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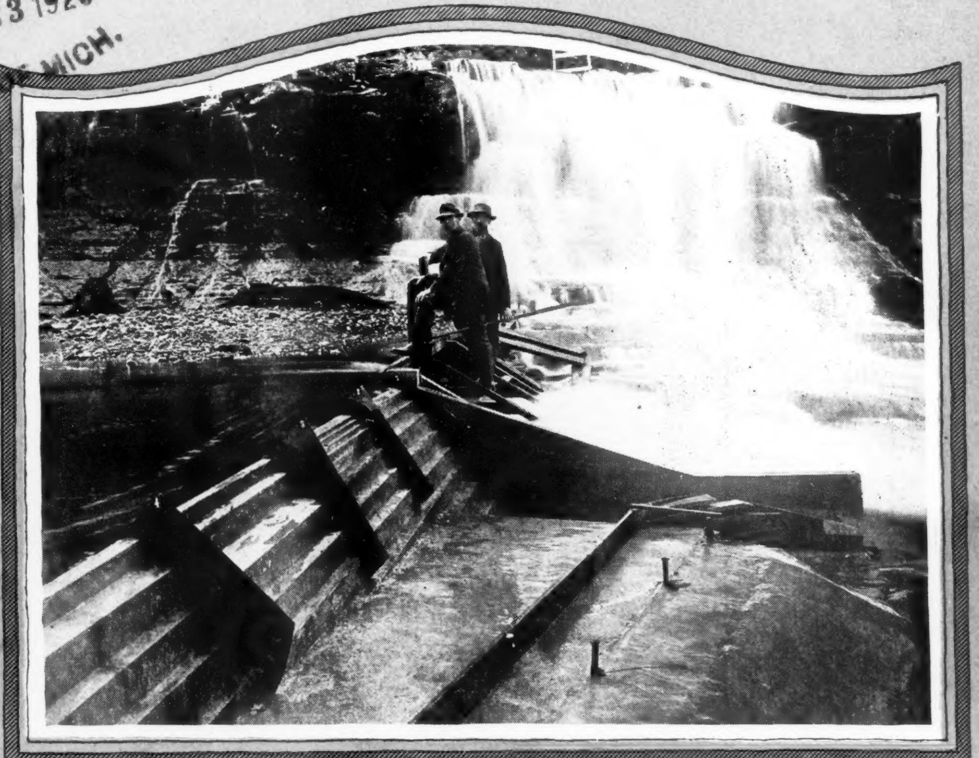

FORCE OF DESCENDING WATERS AT THE GILBOA DAM PROJECT BEING BROKEN BY SERIES OF TERRACES. SEE LEADING ARTICLE

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VOL. XXV, NO. XI

NOVEMBER, 1920

Filling the Cup of a Great City

Compressed Air Plays Notable Part in Impounding Enormous Quantity of Water to Supply Millions of Persons and Industrial Demands

By Robert G. Skerrett

AN ABUNDANCE of water fit to drink is one of the most important matters concerning the welfare of a large city. True, the character of the water supply of any community is of vital moment, but the potential reflexes of vitiation grow in gravity with the measure of the population and the more or less congested circumstances amid which the denizens of a big municipality dwell.

The city of Greater New York came to a realization in 1904 of the need of prompt steps to prepare for the future by providing ample facilities for the impounding of pure water in enormous quantities within some suitable area so that the life-giving flood might be led thence to the Metropolis for distribution through the vast network of the water-supply mains.

In that year the Legislature authorized a very significant preliminary step to this end when the State Constitution was amended so as to remove capital expenditures for waterworks from within the scope of the municipal debt limit. At that time, the population of Greater New York had reached a total of 4,000,000 and the number of inhabitants was then growing at the rate of 115,000 annually. The demand for water was mounting rapidly and was exceeding the safe yields of the available sources of supply—in fact upon several occasions severe shortage had been escaped by a disturbingly close margin.

Happily, the Legislature in the following year passed two bills which created a State Water Supply Commission and also empowered the Metropolis to undertake the construction of such dams, reservoirs, aqueducts, etc., that might be essential to the development of a system calculated to meet the municipality's present and future requirements. The public at large is generally aware of the decision reached to utilize certain areas within the region of the Catskill Mountains; and much has been written descriptive of the Ashokan Reservoir in Ulster County, of the rock-hewn tunnels, of the Hudson River siphon, and of the connecting links of reinforced concrete aqueducts by which the water is led long distances to the Kensico Reservoir, 30 miles north from City Hall.

Similarly, the world has been told how the water is conducted from that basin southward to the Metropolis—the primary artery having been drilled and blasted, from end to end of Manhattan, deep down through the backbone of schist upon which the towering skyscrapers of that teeming borough rest. In a general way the layman knows that the mountain water is carried further through the rock below the East River to Brooklyn and thence under The Narrows to Staten Island, where it pours into the Silver Lake Reservoir after a total journey of 120 miles.

But stupendous as are the capacities of the existing reservoirs, with their accommodations for 190,000,000,000 gallons of water, still it is necessary to tap other sources to make sure that the Greater City's cup shall be filled in the years to come. A decade back, the population of the Metropolis numbered 4,766,800. To-day, there are substantially 6,000,000 within the city's gates.

Further, every working day the transient population amounts to hundreds of thousands, and these people, too, must have a proper allowance of water during their stay. Besides slacking the thirst of millions of human beings and furnishing them with a plenty of water for manifold purposes, industrial developments levy demands that must be recognized so that productive activities on a titanic scale can be carried on continually and without restriction. Up to date, the Catskill water-supply service in active operation has cost the very tidy sum of $139,800,000.

In order that the flow of water feeding into the monster reservoir formed by the building of the Ashokan Dam shall be pretty nearly doubled, the Board of Water Supply of the City of New York is now engaged in putting through a twofold gigantic and spectacular project which will entail an outlay of $22,000,000. This will involve impounding the run-off of the territory flanking Schoharie Creek, reversing the northward course of the stream for the nonce, and then turning the caught water southward through an eighteen-mile tunnel from which it will be discharged into Esopus Creek, whence it will run by that natural channel into the Ashokan Reservoir. Authorization for this latest feature of the Catskill water-supply system was given four years ago, and active prosecution of the work is now under way.

Schoharie Creek lies north of the Esopus district and at a somewhat higher elevation—a fact which the engineers are putting to effective service. In its report of October, 1905, the Board of Water Supply specified that both the Rondout and Schoharie watersheds should ultimately be developed to supplement the Esopus area to assure the desired maximum of 500,000,000 gallons of water daily. At that time, the experts had only a superficial knowledge of the possible availability of the Rondout region. Borings later disclosed subsurface conditions that would make the erection of a dam there a far more expensive undertaking than originally imagined. This was a disappointment, for at first blush that section of the country seemed to offer the easiest route to the Ashokan Reservoir. But this setback was neutralized by developments in another direction.

Run-off data obtained in some of the outlying territory beyond the Esopus was at the start of an incomplete character. Subsequently, however, cumulative and accurate information proved that the dependable yields of the Esopus and Schoharie watersheds were higher than previously estimated. It was established that by placing a dam at Gilboa instead of at Prattsville, as primarily planned, it would be practicable to widen the watershed from 226 square miles to 314 square miles and at the same time amplify the storage facilities from 9,500,000,000 to 20,000,000,000 gallons—the Schoharie alone being capable of contributing under normal conditions, every 24 hours, fully

Fig. 1—The contractors for the Shandaken tunnel had at the start to pack the cement needed for lining the operating shafts up the steep mountain slopes on mule back. When the engineers finished the necessary roads this work was made easier. Fig. 2—Getting a creek bed ready prior to linking it with a vast water impounding system. Fig. 3—The hoisting equipment installed at one of the operating shafts. From the tunnel hundreds of feet below, the excavated rock is lifted and by the same facilities the workmen, the tools, materials, etc., are lowered. Fig. 4—A typical example of the foundation and toe of a Catskill water supply dam. Fig. 5—Breaking a way through the ledge to the starting point for one of the operating shafts. Fig. 6—But for the pneumatic drill the engineers would find it next to impossible to blast and to clear away the ledge upon which a large reservoir dam must have its footing.

250,000,000 gallons. The plan so amended was approved in 1916.

Inasmuch as the tunnel involved the greater working period, that portion of the project was taken up first, and the contract for its execution was awarded on the ninth of November, 1917, to the Degnon Contracting Company—the price being $12,138,738. In advance of this, however, surveys were started immediately after authorization was given in 1916, and detailed subsurface investigations were made by means of extensive borings for the purpose of determining the definite line for the tunnel as well as to fix upon a type of conduit suitable for linking the Schoharie with the Esopus.

At the close of 1919, the tunnel was a little more than eleven per cent completed; and from start to finish the task must be accomplished within a span of seven years. The contract for the building of the Gilboa Dam was awarded in June of 1919, and the constructors are expected to have the job done and the dam ready for service within five and a half years after the start—the idea being to have both the tunnel and the Schoharie Reservoir in operating condition by the close of 1924.

Following the order of procedure in which these two great engineering undertakings have been commenced, let us first describe the Shandaken Tunnel, for such is the name of the passage now being cut through the Shandaken Mountains, which nature has interposed between the valleys tributary to the Schoharie and Esopus creeks. This binding artery will thread its way through solid rock at depths ranging from 255 feet to 647 feet below surface level.

At one point, the tunnel line lies 2,200 feet beneath an overtopping peak; and from end to end of its eighteen-mile length the water main will have an internal height of eleven and a half feet and a width of ten feet three inches. This subterranean conduit will make it possible, when the rainfall is normal, to send daily from the Schoharie Reservoir into the Ashokan Reservoir a contribution of 60,000,000 gallons of water! Of course, the average flow is not expected to be but a little more than a third of this.

The tunnel intake is located about three and a half miles north of the village of Prattsville. From there on the aqueduct extends in a generally southeasterly direction until it emerges just south of the village of Allaben, where its outpouring will mingle with the flow of Esopus Creek. As shown by one of the accompanying illustrations, the tunnel is horseshoe in section and lined with concrete. The line adopted provides for a uniform slope of 4.4 feet per mile except throughout the northerly section of 3.5 miles, which is depressed, and therefore constitutes within that span a pressure tunnel—being entirely charged with water. The rest of the aqueduct will not be filled even when operated at the maximum designed rate.

For the purpose of facilitating construction, seven shafts were sunk from as many different valleys in the overlying mountainous district. These shafts have a combined depth of 3,238 linear feet. The minimum distance between shafts is 1.3 miles, and the maximum interval is 2.7 miles. All the shafts are circular in cross section and lined with concrete, and each of them is surmounted by a house built of native stone. At the northern end of the tunnel there is an intake shaft 174 feet deep, and this is so formed that it will serve as a Venturi meter in which will be set suitable bronze piezometer castings. This arrangement will make it practicable to determine with reasonable accuracy the amounts of water passing at any time southward on the run to Esopus Creek.

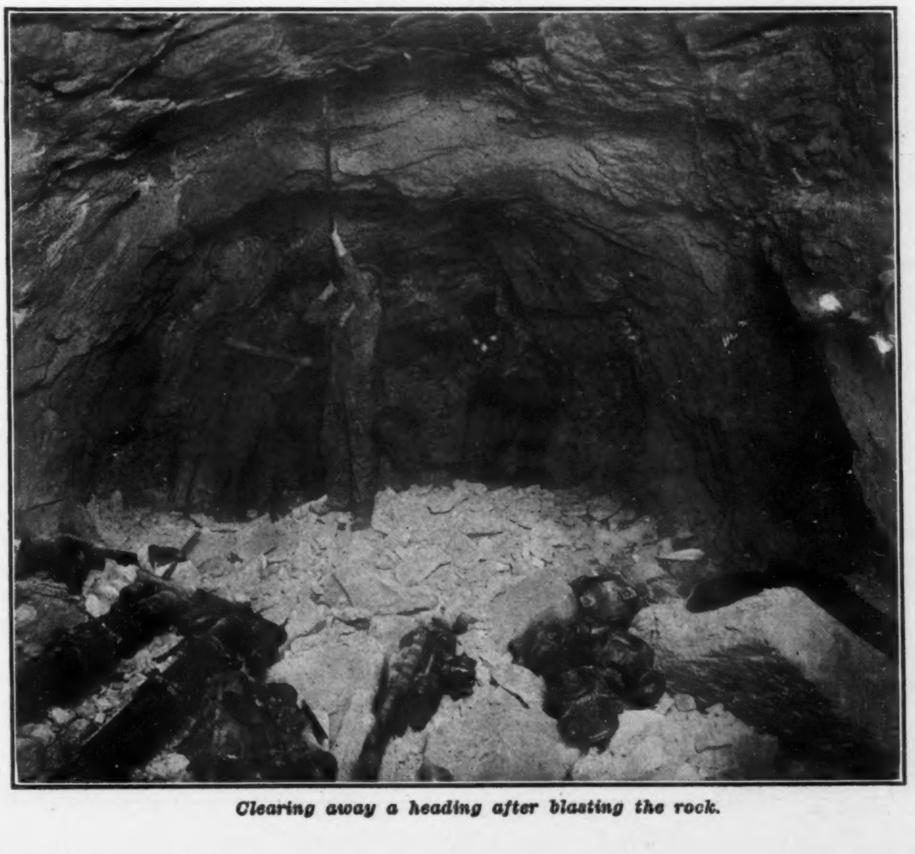
Any one at all familiar with the excavation of rock in the sinking of deep vertical shafts will readily grasp some of the difficulties that had to be mastered in getting below to the chosen levels for driving the actual bore for the tunnel. In this important part of the great task Ingersoll-Rand drills figured conspicuously, making it possible to forge downward with considerable speed. The shaft excavations were not of a uniform diameter, although their internal finished dimension is the same from top to bottom. This variation is due to the fact that the rock, shattered during blasting, was apt, under the pressure of its overload, to spawl when exposed from day to day, and it was therefore necessary to check this tendency by providing an artificial support in the form of a progressively thickening concentric mass of concrete. Therefore, the vertical cross section of a shaft shows a rock excavation of tapering form with its greatest diameter at the bottom.

In placing the concrete lining of the shafts, forms were used which were built of wood, strongly and rigidly fashioned, and made watertight by caulking. For this reason it was practicable to subject the concrete to tamping for the purpose of forcing it laterally into the deepest recesses of the blasted rock. This insured the filling of every crevice and the establishment of a perfect union between the lining and the enveloping ledge.

The innermost section of the shaft lining provides a three-inch coating of concrete over any projecting rock, and the maximum thickness of the concrete shell probably does not exceed a foot and a half. The vertical passage has a diameter fourteen feet from top to bottom, and this has been found ample for the lowering of machinery and other equipment for the raising of spoils, and for the running of the cages by which the men are carried to and from their subterranean work.

Mr. Norman G. Degnon, who is actively in charge of the Shandaken Tunnel contract, has kindly furnished the following details regarding the operative procedure now being pursued. "Briefly, the work of driving the tunnel varies at the different shafts, but in general the operation consists in working two shifts of eight hours each in each heading for drilling and mucking. Heading and bench method is being followed to drive the tunnel, using the top heading and shooting heading and bench each shift. In a heading where the mucking machine is being used, the bench is carried very close to the heading—allowing only room enough in the heading to set up the drills. Three I.-R. No. 248 drills are used in each heading with one "Jackhamer" drill on the bench. Where hand methods are used for mucking, the bench is generally carried 25 to 30 feet in back of the heading.

"The operation consists in drilling about 25 holes in the heading and four holes on the bench for each round. The progress obtained in each round is about six and a half to seven feet for the heading and four feet for the bench: shooting the bench twice in alternate rounds. The muck is shoveled into tunnel cars, either by the mucking machine, or by hand



Clearing away a heading after blasting the rock.

labor, and a storage battery locomotive hauls the cars to the shaft where they are placed on the cages, hoisted up to the upper cage landing and then hand pushed a distance of 40 feet to the tipple where they are automatically dumped into a shoot under which a four-yard Western car is waiting to receive the tunnel muck. A storage battery locomotive next hauls the cars to the spoil bank where the contents are dumped. The dump is started right at the shaft, and the spoil bank is gradually created by shifting and extending the track as the cars are dumped.

"Referring to the methods of excavation, we find that the mucking machine takes the place of about twelve muckers each shift, and is able to dispose of a complete round of tunnel muck in about six hours. A four-hour period is used between shifts for shooting, ventilating, laying track, pipe lines, etc. The sizes of the various pipe lines used are as follows: From the compressor room a six-inch pipe is run down the shaft and extended several hundred feet toward each heading, where it reduces to a four-inch line and thence connects to the high-pressure hose leading to the various drills.

"The water feed line ranges in size from four inches at the bottom of the shaft to two inches and one inch at the headings where the drills are fed. The ventilating pipe is led from the blower to the bottom of the shaft and has a diameter of eight inches; it is then reduced to six inches, and subsequently cut down to four inches as the heading advances. The pump line varies from two to three or four inches, depending on the quantity of water in the tunnel.

"For the sake of those interested in mechanical details, the major plant at each shaft is made up of the following equipment:

Compressors—Two compressors, two stage, size 17"x10"x12". Capacity 741 cubic feet per minute. Each compressor is belt driven by a 130 horse-power synchronous motor.

Blowers—One Connersville blower, 800 cubic feet capacity at ten pounds pressure, direct connected to twenty horse-power motor.

Pumps—Various sizes of Gould and Cameron pumps, motor driven. Number depending upon the quantity of water to be handled.

Cars—Sanford-Day mine cars in the tunnel. Storage battery locomotives to haul cars under ground, and other locomotives of the same sort at work on the dumps. Above ground the dump cars are of the four-yard Western make.

Hoists—One Flory hoist, direct connected to a 120-horse-power induction motor, capable of sustaining an unbalanced load of 7,000 pounds.

Cages—Two cages for each shaft.

Drills—Ingersoll-Rand I.-R. No. 248 drills, using one and a quarter-inch steel. "Jackhamer" drills, using seven-eighth-inch steel.

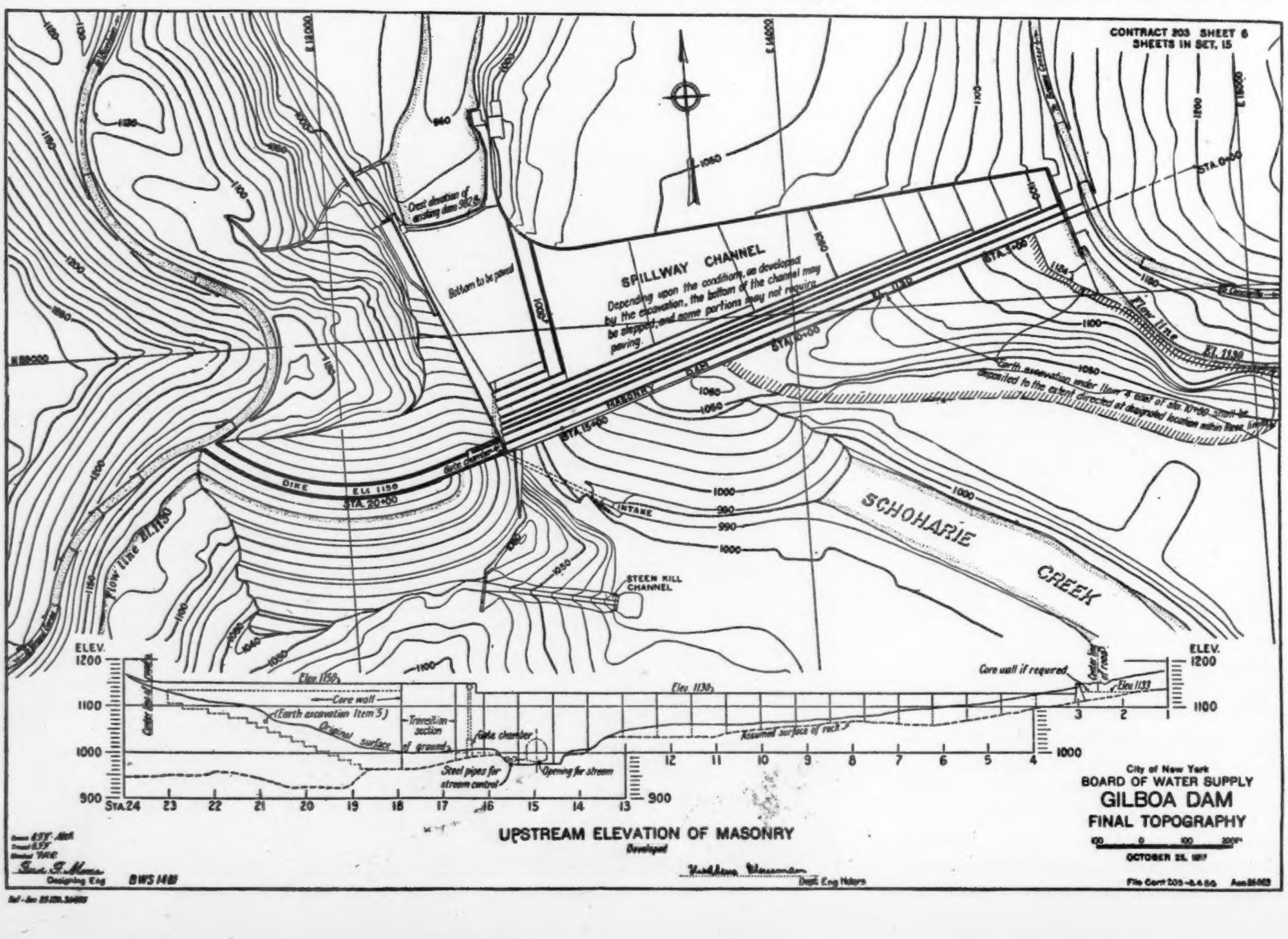
Mucking Machine—One mucking machine at each shaft at the present time. These machines are of the Myers-Whaley pattern, Type No. 4, and their operative capacity ranges in the tunnel service from ten to fifteen cubic yards of loose muck per hour. On the Shandaken contract, the mucking machines are driven by electricity but they are designed to work efficiently under a compressed-air impulse.

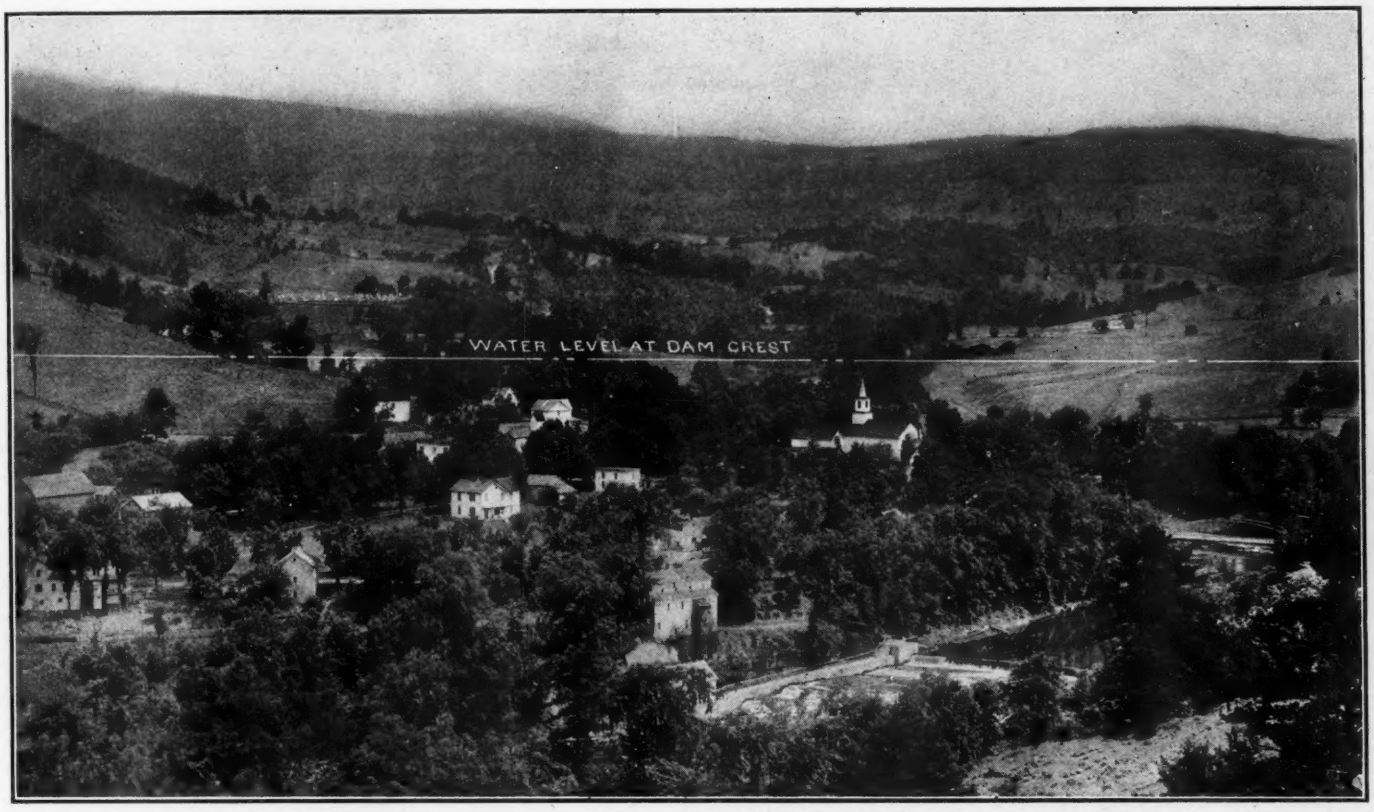
Power—Operative energy for the mechanical equipment is obtained from the Central Hudson Gas and Electric Company at the switching station near Kingston, New York, and is primarily of 60 cycle, three phase alternating current, delivered to the conductors at 33,000 volts. The maximum demand is 3,000 K.W.

The Degnon Contracting Company has constructed a 50-mile, high-tension, three-wire transmission line which carries the current at 33,000 volts from Kingston to the north end of the work at Grand Gorge, distributing power at the shaft points along the way. Substations are located at each shaft for transforming energy from 33,000 volts to 2,200, 440, or 220 volts, as desired. Most of the major plant is operating on 440 volts."

When work was begun on the seven shafts at the several points along the line of the tunnel there were few if any roads through that region of the Shandaken Mountains that were much more than paths, and it was necessary at the start to pack cement and other supplies up into the hills on the backs of sure-footed mules.

On a number of occasions the engineers had to cut their way through virgin timber and to build roads over which the machinery required could be transported to the shaft sites and later lowered into the rocky depths when the driving of the tunnel headings commenced. What this involved can be better understood when it is





The Gilboa dam will cut through the village of Gilboa and the water level at the crest of the dam will rise five feet above the tip of the church spire seen in this photograph. The church stands on the approximate center line of the dam now under construction.

recalled that each mucking machine weighed complete 18,000 pounds, and was made up of three sections ranging from two and a half to four tons each. That the contractors have forged ahead so well is the best evidence of their well-directed energy and their capacity to overcome natural obstacles of considerable magnitude.

In sinking the several shafts into the solid backbone of the Shandaken Mountains it has been necessary to remove 26,700 cubic yards of rock, and the contractors must clear away quite 565,000 cubic yards of rock in driving the tunnel through its eighteen-mile course. The concrete masonry in the shafts totals 9,000 cubic yards, and the lining of the tunnel will involve the placing of about 185,000 cubic yards of the same material. It is estimated that the tunnel project will take in its entirety in the neighborhood of 445,000 barrels of cement, 65,000 pounds of steel for reinforcing concrete, and an aggregate of 330,000 pounds of structural steel. These figures are only a few of the outstanding unit quantities that suggest something of the bigness of the undertaking.

The construction of the Shandaken Tunnel would require more than the prescribed 78 calendar months of work if American ingenuity had not devised mechanical equipment capable of accomplishing much in comparatively short periods of service. Aside from the sinking of the various shafts, in which the rates of progress of the finished jobs has been at least 60 linear feet per month, the contractor has been obliged to do his tunnel excavating at a speed of quite 275 linear feet in each heading every 30 days, and in the same interval he has had to maintain the following advances: trimming invert and setting side-wall footings, 750 linear feet in each heading; lining side wall and arch 700 linear feet in each heading; and lining invert, 2,000 linear feet in each heading.

To live up to this schedule, work is carried on sixteen hours daily, excluding Sundays and legal holidays; and from the base of each vertical shaft tunnelling is done at two headings—driving forward in opposite directions along the line specified.

As the breaking of the way through the rocky foundation of the Shandaken mountains is being effected by drilling and blasting, it is necessary that an ample circulation of air shall be maintained at the headings so as to deal promptly with fumes and smoke. This is necessary for the health of the operatives and to insure clear vision for the surveyors responsible for maintaining an accurate path onward through the bowels of the earth.

By way of supplementing the ventilating system, the contractor has installed boosters or reinforcing fans, which have been set at intervals of about 2,000 feet apart. At the present stage, all incoming water has to be handled by pumps where it is not possible to utilize existing passages in the ledge for its escape.

However, when the portal station is finally reached, any incoming seepage will thereafter be allowed to seek a natural outlet down the tunnel gradient to Esopus Creek.

Under ground, all illumination is by means of electric lights. In the tunnel, lamps of sixteen candle power are placed every 35 feet, and in the shafts lamps of 32 candle power are set the same distance apart. No flame lamps of any sort are permitted in the tunnel or in the headhouses. Telephonic communication is carried on between the tunnel sections and above ground by lines through the shaft.

In cutting the passage through the rock, the contractor is obliged to make his excavation large enough to insure a clearance which will permit an innermost shaft wall of concrete not less than three inches thick. From this artificial shell, radially outward, to the interstices of the shattered ledge, additional concrete and grouting will be forced into place, thus bringing about a perfect and complete union between the shell and the enveloping rock of the mountain backbone.

Inasmuch as the contractor is obliged to give the smoothest practicable finish to the surface of all concrete wherever it forms a part of the tunnel waterway, special means are being employed to obtain this result. The model or mold which is being used for this purpose, and employed repeatedly, is of metal construction designed so that it can be collapsed for stripping and then quickly reset preparatory to pouring. In those sections of the tunnel, however, where there are modifications of shape, the molds are made of wood and covered with light galvanized sheet steel.

At the southern end of the tunnel there will be constructed a portal station where the cut-and-cover section fills the gap between the mountainside and the discharge into Esopus Creek. The outlet chamber and the artificial open channel will be so fashioned that the water from the tunnel will flow without violence into the thread of the stream. The cut-and-cover aqueduct will be built of reinforced concrete and, according to its position, will be either horseshoe or circular in cross section, with a capacity substantially identical to that of the tunnel proper.

The several sections of the cut-and-cover conduit will be fifteen feet in length bound together by steel-plate joints which will provide for the expansion and contraction of the structure longitudinally. As at the intake shaft, the discharge end of the tunnel will be fitted with a Venturi meter, and the bronze piezometer casting will have a diameter of eight feet eight inches.

These two equipments will serve as checks upon each other, and the southern Venturi meter will also permit the engineers to detect leakage from the tunnel should a break occur permitting the escape of any considerable amount of water.

The intake chamber will be surmounted by a commodious stone building in which is to be installed the divers operating equipment which will facilitate the complete control of the passage of water from the Schoharie Reservoir into the tunnel. Power-actuated gate valves will make it possible to close the tunnel intake so that it can be drained for inspection, cleaning, and repair, as occasion arises. For the interest of the reader, fond of comparisons, a better idea of the size of the Shandaken tunnel can be gathered if we consider it in the light of other bores that have been drilled and blasted through the rocky bodies of foreign mountains.

The Mont d'Or Tunnel, which links France and Switzerland through the Jura range, is three and three-quarter miles long; the Mont Cenis Tunnel, under the Col de Frejus, between Italy and France, is eight miles in length; the Loetschberg Tunnel, through the Alps in Switzerland, measures nine and a quarter miles from end to end; and the famous Simplon Tunnel, which also pierces the Alps, has a span of twelve and a half miles between portals. The Shandaken Tunnel, therefore, measuring eighteen miles from intake to outlet, will surpass any of these previous undertakings in the matter of length.

And now for that other half of the project which will stand forth in the light of day to bear visible testimony to the splendid proportions of the scheme. Gilboa Dam, on which work has commenced, will rise athwart Schoharie Creek four miles northeast from the Grand Gorge station of the Ulster and Delaware Railway—a point 120 miles in an air line north of City Hall, in the Borough of Manhattan, and 35 miles west of the Hudson River.

The tributaries of the Schoharie have their sources at elevations of nearly 2,000 feet, in the heart of the higher section of the Catskill Mountains. The character of the watershed is similar to that of the Esopus district, and consists mainly of steep mountains formed of shale and sandstone with a covering of dense forest growth. The streams are subject to freshets in the spring season, and because of the nature of the country the flow in these waterways is decidedly large in proportion to the rainfall. That is to say, 69 per cent of the precipitation finds an outlet by way of the Schoharie.

While the Esopus runs out of the Catskills through the southerly gateway toward Kingston and the Hudson River, the Schoharie, on the other hand, follows a northerly course and finds its natural outlet in the Mohawk River, near Amsterdam. It lies at a sufficient elevation to permit its flow to be intercepted by a dam at Gilboa. This obstruction will reverse the direction of the stream, impound its waters in a convenient valley, and divert all but its excess southward through the Shandaken Tunnel.

The main features of Gilboa Dam are all characterized by magnificent proportions. The construction, when finished, will include about 396,000 cubic yards of earth excavation, 617,000 cubic yards of refilling and embanking, and 436,000 cubic yards of masonry which will call for the use of quite 480,000 barrels of Portland cement.

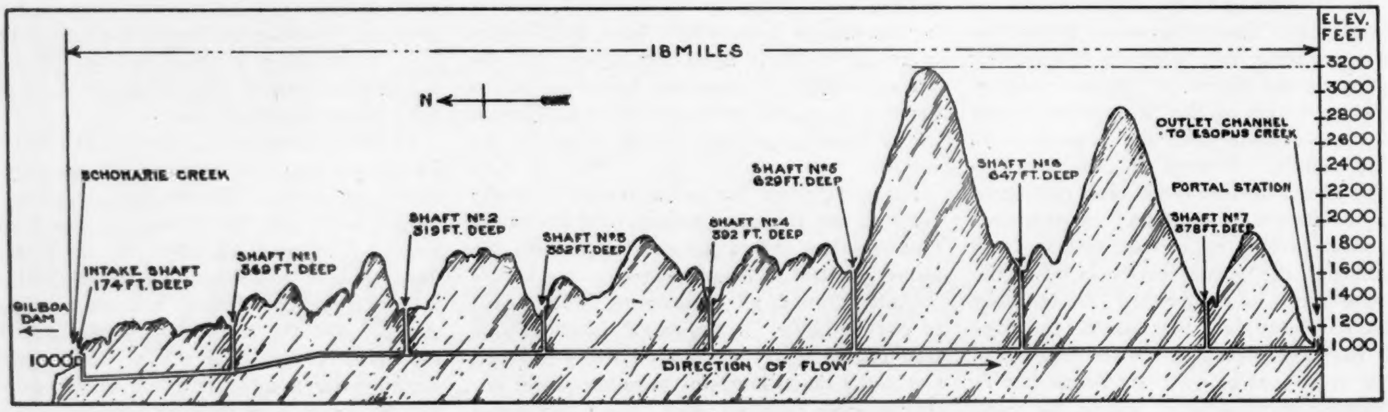
Broadly, the dam will consist of two main parts: an overfall masonry section, having a maximum height at its crest of 160 feet and a length of 1,300 feet, and an earth section 1,000 feet long which will be stiffened by a masonry core-wall. The earthen section will rise 20 feet above that of the overfall portion of the dam structure.

The Gilboa Dam will be distinguished in its active functioning from the dam at Ashokan and Kensico by the fact that flood waters will flow over its top. This has imposed the adoption of a radically different type of face for the down-stream slope—the height of the fall necessitating recourse to measures that can be counted upon to rob the descending waters of much of their impacting violence preparatory to returning them into the natural channel of Schoharie Creek. The 1,300-foot overfall division of the dam is being built of cyclopean masonry composed of large blocks of stone buried in concrete. At the top the minimum thickness will be fifteen feet and at the base it will have a maximum thickness of 165 feet. The reservoir side of the structure is to be faced with natural stone as far down as the water will be drawn off. The spillway will be arranged in a series of terraces or steps having a tread and rise varying from ten to twenty feet, and these will be surfaced with local bluestone. The overfall corners are to be formed of the largest stones that can be obtained in the neighborhood, and these will be set on edge and securely anchored. The masonry section of the dam rests on solid rock.

The 1,000-foot earth section, on the west or left bank of the Schoharie, is required by reason of the pre-glacial gorge, which there swings under the mountainside. The masonry overfall where it joins the earth portion of the dam will be flanked at right angles, both upstream and downstream, by long, high, and heavy retaining walls, which are to be faced with natural stone. These walls will intercept the earth slopes and protect them from the erosive action of the water.

Beyond these walls, reaching into the center of the earth section, and tied to the masonry of the overfall structure, there will be a high tapering core wall which will run throughout the length of the earth embankment and be anchored in the mountainside. At points, the earth division of the dam will have a height of more than 100 feet and a spread at its base of fully 400 feet. The slope in contact with the water of the reservoir will be paved with heavy stone to check erosion and to prevent the fouling of the water when the surface of the reservoir is agitated by strong winds.

The spillway of the dam has been designed after careful model tests, which have been inspired by two problems. First, the selection of steps to break the force of the descending waters in times of flood, and, next, to devise a channel that would catch the major volume of the overpouring waters and divert them at an angle of about 90 degrees into an artificial basin, suitably paved, leading directly into the normal bed of the Schoharie north of the dam. These questions have been answered in a skilful manner; and just how this has been achieved, after considerable research, is



A cross-section of the rock-ribbed mountains through which the Shandaken tunnel is being driven. The elevations represent heights above sea level. No inconsiderable part of this great engineering work has been devoted to sinking the seven working shafts from the mountain valleys down to the chosen line for the tunnel. These shafts had all of them to be made big enough to permit of the passage of the excavational machinery and have been lined with concrete and reinforced with the utmost care.

shown by one of the illustrations accompanying this article. For the sake of making the drawing plainer, a brief description is pardonable.

For a comparatively short distance at the western limits of the masonry dam, close to the earthen dike, the overflowing water drops right down the steps of the spillway into what might be termed a catchment basin, but for the major portion, the descending waters fall varying heights onto the terraced slope of a tapering spillway channel, which has a gradient of more than 100 feet from top to bottom. This arrangement is distinctly unique, and the tumbling waters are so guided against themselves that they are effectually sapped of much of their momentum and directional force—finally reaching the original creek bottom in an eddying condition that robs them of their capacity to damage the flanking banks. As a spectacle, Gilboa Dam is likely to present an impressive picture when abundant rain-fall fills the Schoharie Reservoir to a stage of riotous overflow.

The Schoharie Reservoir will obliterate the village of Gilboa, and the water surface will have an expanse of 1,170 acres, while the land acquired to carry out the project totals 2,372 acres. The reservoir will have a length of five miles, a maximum width of four-fifths of a mile, and a shore line of twelve miles, and the crest of the dam spillway will be 1,130 feet above the level of the sea. The maximum

Fig. 1—Another phase of work in building a cut-and-cover section of the Catskill aqueduct. Fig. 2—The removal of tunnel spoils is being effected by means of electrically propelled trams.

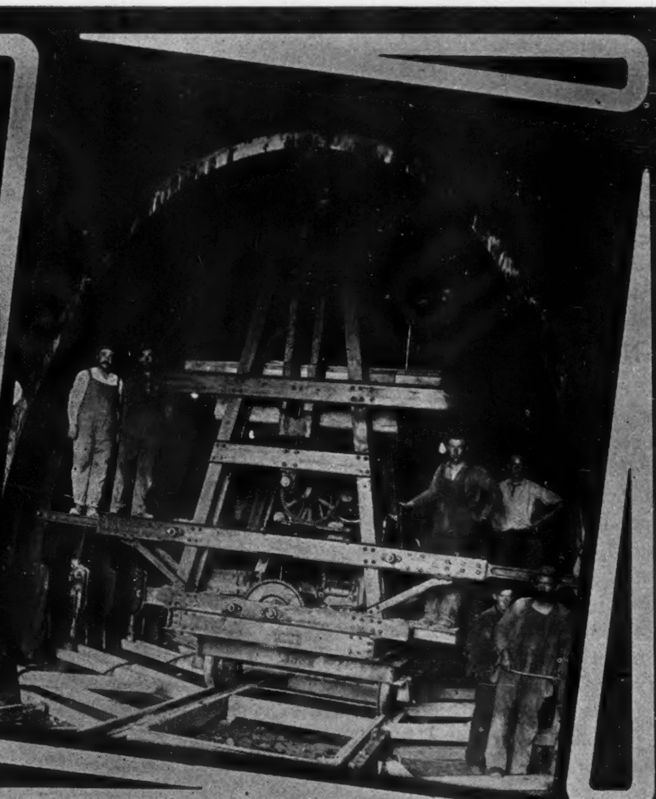


Fig. 1—Here we have a rather extensive stretch of a cut-and-cover section of the gigantic artery which conveys water from the Catskill Mountains to the populous Boroughs of Greater New York. Fig. 2—An example of an electrically operated car used in removing and shifting steel forms employed as molds during the construction of a cut-and-cover link in the aqueduct system.

depth of the reservoir will be 140 feet and the average depth 58 feet. The undertaking will involve the closing of 13.6 miles of highways and the construction of 12.4 miles of new roads, and will require the building of two bridges.

It is probably no exaggeration to say that no other city of considerable magnitude anywhere has a water supply of the purity and per capita volume equal to that of Greater New York at the present time and potentially. When the Schoharie development is finished, the dwellers on Staten Island, in the Borough of Richmond, will fill their cups with water after it has journeyed 156 miles from the heart of the Catskills. So big are the impounding reservoirs that they can insure even during months of drought an ample supply for the millions living within the teeming Metropolis.

LATEST AND MOST BRILLIANT ELECTRIC LIGHT

The most intensely brilliant artificial light in the world is that produced by the flow of electric current between two pencils of carbon. The supremacy of this carbon arc lamp is threatened by a new type of lamp, in which an arc is "struck," as the phase goes, between two minute globules of tungsten in a vacuum bulb similar to that of an ordinary electric lamp. Just before the war British research had produced a lamp of this type with 100 candle power, and the resumption of the investigation after the stress of war has enabled a means to be discovered of producing larger globules, so that lamps of much higher candle-power have been made. At an early date one with 4,000 candle-power will make its appearance. As the source of light is practically a point, the lamp is very suitable for kinematograph work and for various microscopic and surgical purposes. Being rich in the actinic rays which act on sensitive plates it has also a wide scope in photography. Its efficiency is very high, though not quite so high as that of the latest types of arc lamp, and its simplicity, its convenience, its long life, and the absence of flickering in the light are likely to make this British invention very popular wherever a concentrated light is required.

HEXANITRODIPHENYLAMINE

A new explosive with the above name—Hexil, for short—is spoken of favorably as a booster material. (1) It is superior to TNT, but somewhat inferior to tetryl and TNA. (2) It is extremely stable, and is safer to handle than either of these. (3) It can be manufactured by a single process from sources which would not conflict with TNT manufacture, and because of the excellent yields obtained, and the cheapness of intermediates for it, its material cost should be less than for either tetryl or TNA. (4) On account of the simplicity of the process, the installation of a plant for its manufacture would be less expensive than for an extension of the manufacture facilities for either tetryl or TNA. (5) On account of the simplicity of operating methods, labor costs would be less than for either of the other materials.

DRILLING NINETY-EIGHT HOLES IN EIGHT HOURS

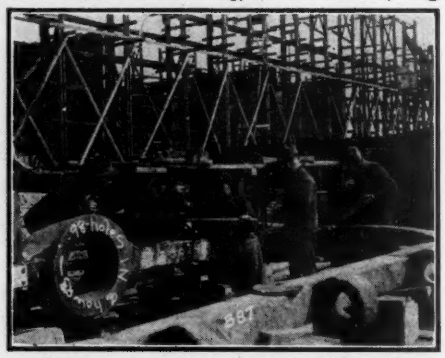
By C. W. GEIGER

THE accompanying photographs were taken at the shipbuilding plant of the Schaw Bacher plant, South San Francisco, and show methods of drilling with air drills. Fig. 1 shows the method of drilling a casting in which a record of 98 holes was made in eight hours.

The holes were drilled in the stern post of a 9400-ton freighter in September, 1919.

The following data were recorded.

The holes were 1-13/16 in. diam.; eight



A drilling crew at the Schaw Backer plant

inches deep; two drilling machines were used, operated by two drillers and two drillers' helpers.

About 42 cubic feet of air per minute was consumed for one machine or 84 cubic feet for the two machines per minute.

The air pressure was 100 pounds and the size of motor operating the air compressor was 120 horsepower.

The cost of running the compressor amounted to $100 per day for the entire yard. The method of distributing the air for these drill-

Drilling 98 holes in eight hours

ing machines is by eight-inch pipe lines from the compressors or to the manifolds and then through three-fourth-inch hose to the machines.

The air compressed for consumption in the yard daily is 11,000 cubic feet per minute at 100 pounds pressure.

The men received the sum of $43.12 for the drilling of the 98 holes in the stern post, which, including cost of running the compressor, makes a total of $143.12.

The National Tube Co., Pittsburgh, has started work on 26 new houses for use of its employes at its Ellwood City, Pa., works.

SYSTEMATIC CARE OF ROCK DRILL STEELS

In the shop of the Champion Copper Company, as described by *Mining and Scientific Press*, there is a special routine for the handling of drill steels from the mine. The drills are received at the shop in iron baskets, those from each party of miners being ringed in separate bundles and each drill stamped with the serial number of the party. The baskets are lifted from the wagon or truck by an air-lift supported by an overhead trolley, and run onto the sorting platform. Here they are sorted and records taken showing the number returned by each party. Drills needing repairs are placed on a rack from which they go to the repair forges. The rest are placed on the rack at the heating-furnace, which is at present fired with coke, although one using oil with pyrometer control will be installed. The bits are heated to about 1,900 degrees F. the proper degree of heat being judged by color, and then go to the sharpeners. Incorporated on the sharpener is a quick-acting air-cylinder operating a long pin used to clear the hole in the steel, should this be found necessary. In sharpening, care is taken to pull out the corners that have become rounded from use. The device for doing this is a part of the fullering-die and consists of a pair of inclined planes set at an angle of 100 degrees. Care is also taken that each operation in the sharpener is not carried too far. In other words, the bit receives a few blows from the fullering-die, then a few from the dolly; it then goes to the gauging-block, then back to the dolly or fullering-die, and so on, until the proper shape is obtained. After sharpening, the bit is tested by the gauging-ring and the drill placed on an inclined rack, which delivers it to the re-heating or hardening furnace. This was formerly a coke-furnace, but an oil-furnace with signaling pyrometer control is now used, affording an improved regulation of the heat. The importance of proper treatment of drill-steel has been emphasized more than ever by the results obtained in the all-around increase in efficiency.

DANGEROUS ELECTRIC COAL CUTTERS

Serious trouble of an old kind has occurred at Mount Kembla Colliery, in New South Wales. The miners declare that the mine is dangerous because of the large percentage of inflammable gas in certain sections of the pit, and the large quantity of dust created by the electric coal-cutting machines. It is stated that the machines cause sparks when they strike stone or brass or other foreign substances, and the risk of igniting the gas and the coal dust is too apparent to be regarded lightly. The miners' district secretary states that since the introduction of electric coal-cutters there has always been uneasiness among the men, especially since the disastrous explosion in 1902, because of the dust created and the danger of sparks. The upshot of these apprehensions was that at a recent meeting of the Mount Kembla Miners' Lodge it was decided not to go to work until the electric coal-cutters were abolished.

MICHAEL P. GRACE

THE death of Michael P. Grace at his home in London on September twentieth, was a very definite loss to the compressed air industry.

For many years Mr. Grace and his late brother W. R. Grace, who was twice Mayor of New York, were very active in the direction of affairs of the Ingersoll-Rand Co. The guidance of the company through the many stages of its development called for most excellent judgment and unusual vision. The standing of the institution today shows that these two pioneers possessed an abundance of these sterling traits.

At the time of his death Mr. Grace was, notwithstanding his advanced age, a member of the board of directors and in close touch with the affairs of the company.

During the greater portion of his career Mr. Grace was associated with that group of men who played such a prominent role in the upbuilding of America's foreign commerce. As chairman of the board of directors of the W. R. Grace & Co. it was given to him to behold the unparalleled growth of American business at home and abroad and particularly the development of the Grace organization, which rose from a humble beginning in Peru to a point where it counts its 167 branches in 26 different countries. Where a mere handful of men were able in the early years to satisfy the demands of the business, the Grace firm now numbers its employees in many thousands.

His world-wide circle of devoted friends received the announcement of his death with expressions of genuine sympathy for they had lost a real friend.

Mr. Grace's commercial career began in the sailing ship era. He was born in Queenstown, County Cork, Ireland, in the year 1842. At an early age he went to Peru where his father, James Grace, had sought to establish an Irish agricultural community, and where his elder brother, W. R. Grace, had become a partner in the trading firm of Bryce, Grace & Co. Here he assisted in building the business of W. R. Grace & Co. to its present world wide scope.

The Grace Brothers, Wm. R. and Michael P., were to a large extent the inspiration of the Ingersoll-Rand and Grace firms. They were responsible for the principles upon which these firms were so successfully founded. Both these men were extremely modest and Mr. W. R. Grace was frequently heard to say that his brother, Michael P. Grace, was the business genius of the family.

In 1868 Mr. W. R. Grace came to the United States where he established the house of W. R. Grace & Co. It operated a vast fleet of sailing ships, and held the Peruvian government agency for the sales of nitrate of soda, managed by Baring Bros. in Europe and W. R. Grace & Co. in New York. After the Chile-Peruvian war of 1877-1881, Mr. W. R. Grace, who, by this time had become an American citizen and had assumed charge of the parent house in New York, had returned to Peru to further develop the business and extended it to Chile.

In 1887 the house was asked by a committee of Peruvian bond holders to attempt a settlement of the Peruvian foreign debt, and for this purpose Mr. Michael P. Grace was active in the establishment of the Peruvian corporation which undertook large projects for the development of Peruvian resources and industries and the construction of Peruvian railroads. Their negotiations required the establishment of a branch house in London under the name of M. P. Grace & Co., which later became Grace Bros. & Co., Ltd. During the later years of his life Mr. Grace divided his time between the New York and London offices.

MICHAEL P. GRACE

It is seldom that one man can encompass within the usual sphere of a life time the varied experiences and different interests in which Mr. Grace engaged.

The keynote of Mr. Michael Grace's character was revealed in an address he made at a dinner recently given to the members of the home office of the Grace organization. In paying tribute to the labors of the directors of the firm he summed up his remarks saying:

"If you can concentrate upon your work as these men have done, success for you is certain." In an article published in *The Grace Log* he emphasizes two qualities which characterized his long and useful career. He said: "It took some years to build up business in a new country and it was some years before prosperity returned to Peru, but *steady work* and *careful perseverance* accomplish everything."

He was buried at Battle, England, the historic site of the Battle of Hastings.

A refrigeration plant which is part of the research laboratories of the Dayton Engineering Laboratories Co., Dayton, supplies a cold room for motor starting tests, with 400 cubic feet of air per minute at zero degrees Fahr. The incoming air is at 90 degrees Fahr., 70 per cent saturation.

After October 1, on all the railroads throughout Russia, workmen and families on leave, or changing places of employment, consignments of authorized merchandise or government consignments, invalids, students, will receive free transportation.

THE HOLDING-THE-BREATH TEST

An important test for would-be aviators is the measurement of the time one can hold his breath. It enables the physician to obtain a fair idea as to the stability of the central respiratory nervous apparatus. According to a recent writer in *The Lancet* (London) a stop-watch and a nose-clip are all the apparatus required, while the precise instructions as to carrying out the experiment are equally simple. The time the man can hold his breath before the inevitable and forceful sensation of the need to breathe compels him to give way is noted. The average time in the normal fit pilot is sixty-nine seconds, the minimum being forty-five seconds. Nearly all cases with a time-record as short as this were rejected on medical grounds apart from this test. Not the least interesting part of the test as applied to airmen is the reply given when the examinee is asked what caused him to give way and breathe in, the normal response being, "I had to give up," or "I wanted to breathe." Under conditions that point to unfitness for pilotage the reply may be, "I felt giddy," or "dizzy," or "squeamish," or "flushed," responses which indicate that other nerve centers are involved besides the true bulbar respiratory center. Such extraneous sensations, so markedly different in character from the pure inspiratory impulses, enable the observer to form conclusions, not only as to the stability of the respiratory center itself, but indirectly of those other parts of the central nervous system whose stability plays an important part in the nervous outfit of the aeronaut. The combination of minimum time record and abnormal verbal response points to the examinee being one likely to suffer from oxygen hunger at high altitudes, and possibly to an inherent inability, by a strong effort of will, to carry on under conditions of stress. The breath-holding test may have a similar application in other branches of medical practise. It was effectively used by Dr. H. F. Marris, in an attempt to estimate the factors in the production of tachycardia (rapid heart-beat) occurring in febrile illness. . . . The general practitioner might add it to his armamentarium.

OIL PIPE LINES

The total mileage of oil pipe lines in the United States is now about 34,000, and the "gathering systems" 11,500, making a total of 45,500 miles. At the time most of the lines were constructed, say the experts of the Geological Survey, the average cost per mile, based on the eight-inch pipe, was $6,500; and the cost of the average pump station was $130,000 to $250,000. The pipe usually used is eight inches in diameter and the specifications require that they be of uniform quality of steel, with threads to make possible a perfect union at the joints and capable of withstanding an internal pressure of 2,000 pounds to the square inch. The Survey records the work of one pipe-laying machine, operated by a gang of 28 men, which laid 8,700 feet of eight-inch pipe in one day of nine hours. The usual accomplishment of a gang of 40 men is from 2,500 to 4,000 feet per day.

PETROLEUM IN THE MOVIES

A new four-reel motion picture film telling the story of petroleum has just been completed by the United States Bureau of Mines in coöperation with the Sinclair Consolidated Oil Corporation, the same to be loaned for educational purposes to responsible parties who will put in their requests. In this film the entire story of the petroleum industry, including prospecting, production, refining, distribution and its ultimate uses, is shown in such a way as to be readily understood by the layman as well as the engineer student. Applications should be addressed to the Director, U. S. Bureau of Mines, Washington, D. C.

Personal Intelligence

Edmund S. Nash, President of Rosin & Turpentine Export Company, has returned from a month's trip to England.

* * *

Thos. W. Pangborn, president, John C. Pangborn, vice-president, and W. C. Lytle, general sales engineer of the Pangborn Corporation, Hagerstown, Md., attended the Foundrymen's Convention held at Columbus, Ohio.

* * *

Sir Aukland Geddes, the British Ambassador, was one of the speakers at a banquet given at the Shorehame Hotel, October 6, by the Chamber of Commerce of the United States in honor of a delegation of English business men who attended the Congress of Chambers of Commerce of the British Empire, which has just come to a close at Toronto, Canada.

* * *

The Directors of The C. & G. Cooper Company of Mt. Vernon, Ohio, at the regular June meeting elected Mr. B. B. Williams President of the Company to succeed Mr. D. B. Kirk, deceased. Mr. F. H. Thomas was elected Vice President to succeed Mr. Williams, Mr. N. L. Daney was elected Treasurer to succeed Mr. Thomas, and Mr. Taylor is Secretary in charge of Production.

* * *

Of more than passing interest to the trade is the announcement that Mr. A. B. Way, until recently secretary and general manager of The Bridgeport Chain Company, has become affiliated with The Chain Products Company of Cleveland, Ohio, in the capacity of District Sales Manager for New England, with headquarters at the Company's New York Office, 150-152 Chambers St. For many years, prior to his identification with the chain industry, Mr. Way had been affiliated with various New England manufacturing institutions. Mr. Way carries with him the best wishes of his many friends in the industry for his complete success in his new undertaking.

* * *

Mr. Julius Janes, formerly President of the Standard Steel Castings Company, of Cleveland has recently concluded an arrangement with The Farrell-Cheek Steel Foundry Co. of Sandusky, Ohio, by which he will be the Sales Representative of this organization in Cleveland and Cuyahoga County.

Benjamin Smith Lyman, mining engineer, geologist and first to make a geological survey of Japan, died recently at Cheltenham, Pa. He was 85 years old. Mr. Lyman was born in Northampton, Mass., on Dec. 1, 1835. He graduated from Harvard in 1855 and completed a course in the Ecole des Mines, Paris, in 1861. He also studied in the Royal Academy of Mines, at Freiberg. Mr. Lyman was employed as a mining engineer by the Public Works Department of India, and from 1873 to 1879 he acted as chief geologist and mining engineer for the Japanese Government. He later acted as State geologist in Pennsylvania. He was a fellow of the American Association for the Advancement of Science and the American Institute of Mining Engineers. Mr. Lyman was an honorary member of the Mining Institute of Japan.

* * *

Robert C. Montgomery of the American International Corporation and head of the Tax Department, has returned from a four months' trip to Europe where he studied taxation laws. Mr. Montgomery says that the United Kingdom has developed the best law and procedure in taxation of any country, including the United States. France is only now beginning to collect taxes after developing a system of excess profit taxes during the war, and in Italy, too the authorities are slow in collecting the excess profits and incomes taxes imposed during the war.

* * *

Colonel E. B. Cushing, engineer of maintenance of way for the Southern lines in Texas and Louisiana, has retired to private life after 40 years' service with that company. Colonel Cushing will be succeeded by Mr. H. M. Lull, who is now division engineer. Mr. Lull's title will be chief engineer of the Southern Pacific lines of Texas and Louisiana. With the exception of two years Colonel Cushing has been in the Southern Pacific service since 1879. He was identified with the construction of the road from San Antonio to El Paso, from Spofford, Texas, to Mapimi, Mexico, and other secondary branch lines that make up the present system, which has 3,684 miles in operation.

* * *

A. C. Bedford of New York, chairman of the Board of Directors of the Standard Oil Company of New Jersey, has sailed for Paris to attend the first meeting of the Board of Directors of the International Chamber of Commerce to be held on October 11. Mr. Bedford, who is one of the vice-presidents of the Chamber of Commerce of the United States, was elected vice-president of the International Chamber at the organization meeting last June.

* * *

Two men were recently rescued from death in Indiana coal mines through the bravery of fellow-miners and a knowledge they had gained in mine rescue work from the United States Bureau of Mines which had just completed a course of training among these miners. It is declared by the rescuers themselves that the two men would have lost their lives if the old methods had been employed.

Air in Chemical, Metallurgical and Related Industries

The Installation of Compressors, Blowers and Fans in these Fields Is Constantly Increasing as New Uses Are Being Discovered*

THE CHEMICAL and related industries are those in which the manufacturing operations are required to be in charge of trained men and operated along chemical engineering lines.

The scope of these industries is exceedingly broad. The tremendous development in these fields during the war simply forecasts the enormous advances to be made in the new industrial era at hand.

Since the first of the year many contracts have been let for the building of new plants and the enlarging of present ones. Millions of dollars of capital are being employed in the evolving of new processes and the developing of our unequalled raw material and water power resources.

This development in the chemical and related industries is accompanied by a tendency to standardize processes and process equipment. Processes which, formerly, have been operated independently, surrounded by a mantle of secrecy, are becoming a matter of common practice.

A more definite idea of the character and scope of these industries may be gained by a study of the following discussion regarding the application of air in chemically controlled plants.

Compressed Air in Chemically Controlled Industries

Some of the principal controlled industries using compressed air are:

Acids	Salt
Alkalies	Soap
Ceramics	Sugar
Glass	Gas
Dyes	Paint
Explosives	Cement
Fertilizers	Iron and Steel
Abrasives	Sulphur
Pulp and Paper	Electrolytic
Petroleum Products	Metal Refineries
By-product Coke	Packing House Products
Tannery Products	Non-Metal Mining

A large majority of these industries find a "general" use for compressed air as distinguished from a specific process application.

Transferring of liquids from one piece of equipment to another.

Loading or unloading tank cars, tank bodied trucks, etc.

Charging elevated tanks or discharging underground tanks.

Stirring liquids in tanks and dissolvers by introduction of air through perforated pipe, hose, etc.

Blowing liquids in fine spray into absorption towers.

Blast for crude-oil industrial furnaces.

Atomizing liquids to accelerate reactions.

Pressure to accelerate reactions in autoclaves, tanks, etc.

Compressed air piped for laboratory blast, blow pipes, ect.

Compressed air for machine shop use.

Pumping of low temperature water from wells for condensing and other purposes.

Cleaning of evaporator tubes.

Testing of vacuum and pressure equipment.

A few of the more specific uses are:

Forcing by-product coke oven gases through solvents.

Oxidation by air as in manufacture of sulphur-black.

Concentration of potash-lye by blowing hot air through liquid.

Petroleum refinery operation of forcing superheated air through oil which is being distilled.

Operation of furnaces for petroleum and tar distillation.

Pumping of brine from deep wells.

Pumping of molten sulphur.

Blowing of window glass, bottles.

Cleaning of coke from petroleum—refinery stills by means of pneumatic tools.

Steel plate construction for petroleum storage tank, etc.

Blast furnace operation.

Survey of Industries

This investigation which is carried out among a considerable number of companies was made possible by the enthusiastic coöperation of plant executives. The companies selected at random constitute a body representative of the entire field. One hundred and thirty-five companies participated in the survey; 108 out of 135 companies participating are users of compressors, or in other words, 79%. The 108 companies own 273 compressors, or an average of 2.5 compressors per company. The following table shows the various makes of compressors operating among the companies investigated:

MAKES OF COMPRESSORS OPERATING AMONG THE COMPANIES INVESTIGATED.

Ingersoll-Rand	93
Westinghouse	19
Nordberg	14
Laidlaw, Dunn, Gordon	16
Sullivan	11
Chicago-Pneumatic	10
Gardner	11
Bury	7
Curtis	5
National Brake & Electric	4
Clayton	4
Rix	4
Allis-Chalmers	4
Blaisdell	3
General-Electric	2
Norwalk	2
Fraser-Chalmers	2
Union Steam Pump	2
Worthington	2
American	2
Nagle	2
Petrick	2
Dervilluss	2
Cleveland	1
N. Y. Air Brake	1
Daak-Gas	1
Marsh	1
Fairbanks-Morse	1
Baker-Hansen	1
Crowell	1
Nash	1
Portable Nat. Air Brake	1
American Well Works	1
Bruce Macbeth	1
Western Supply	1
Parker	1
Peerless	1
Guild and Garrison	1
Herron and Burry	1
Wicks Bros.	1
Not Stated	43
Total	273

SIZES OF COMPRESSORS

Horse power	*Number*
0-25	51
25-50	15
50-100	24
100-200	12
200-300	8
300-500	14
500-1000	16
1000-2000	1
2000-3000	2
Not Stated	130

CLASSIFICATION OF BY-PRODUCTS OF COMPANIES FURNISHING INFORMATION

Product	*Number of Companies*
Acids	4
Alkalies	5
Explosives	2
Dyes	4
Oils and Greases	2
Petroleum Refining	2
Paint	3
By-product Coke	2
Fertilizers	3
Cement	3
Fibre	1
Packing-House	3
Chemicals	6
Glass	3
Rubber	2
Gas	2
Pottery	2
Chemical Plant Equipment	2
Limestone Quarry	1
Dust Recovery Equipment	1
Steel	2
Mines	8
Smelters	7
Metal Refineries	12
Rare Metals	1
Brass	1
Brick	2
Wood Products	1
Wood Preservatives	2
Sugar	2
Baking Powder	1
Storage Batteries	2
Paper	3
Dental Supplies	2
Insecticides	1
Roller Bearings	1
Foundries	3
Insulating Compounds	1
Carbon Products	3
Industrial Laboratory	1

USES OF COMPRESSED AIR

The uses of compressed air enumerated by the 108 companies are as follows:

Use	*Companies so using*
Hoisting	9
Pumping and Air Lifts	26
Blowing Motors	11
Pneumatic Tools	33
Agitation	15
Oil Furnaces	5
Pressure Regulators	3
Filter Presses	4
Pneumatic Press	8
Air Converter	3
Sand Blast	3
Mixing Oil	3
Paint Machine Spray	2
Blowing Liquids	2
General Uses	33

SOME MORE SPECIAL USES INDICATED WERE

Atomizing Zinc Dust	1
Cottrell Dust Treater	2
Porcelain Kilns	1
Cleaning Boiler Tubes	1
Glaze Spraying Machines	1
Aerating Cyanide	2
Timber Treating	1
Air Locomotives	3
Pre-heaters	4
Dusting Unfinished Pottery	1

*Abstract of a brief prepared by R. L. Patterson, chemical engineer for the Chemical and Metallurgical Engineering Research Service Department.

Blast Furnaces	2
Kerosene Burner Equipment	1
For Diesel Engine	1
Tamping Machines for Lining Copper Converters	1
Pneumatic Tools for Removing Coke from Petroleum Refinery Stills	1

This mass of information also reveals that these industries present a large market for compressed air accessories such as hammers, pumps, locomotives, drills, etc.

Oil Production

Compressors are used in the oil fields in connection with well drilling, pumping and transportation of oil, etc.

In the petroleum refinery, the raw materials, the finished products and the chemicals employed are in liquid form. Compressed air is used for transferring these liquids from one vessel to another. For the loading and unloading of tank car compressed air is often employed as well as for the charging and discharging of "crude oil stills," "tar stills," and for pumping napthalene, light distillate, paraffine distillate, caustic lye, sulphuric acid, finished oils, etc.

Compressed air is much used for agitation in refining processes. In treatment of the "illuminating oil fraction," agitation is carried on with the acid addition, the alkali addition, and the washing. In deodorizing processes agitation is sometimes continued for six-hour periods.

In distilling operations superheated air is often forced through the oil being distilled. Compressed air is also used for pressure distillations.

Asphalt is prepared by blowing air through petroleum residues. Much asphalt is prepared in this manner for paving and roofing purposes.

Pneumatic tools are extensively employed for cleaning the hardened residue or cake from the tar stills. This operation formerly performed with pick axes required much time and labor.

The petroleum refining industry requires vast amounts of steel plate equipment in the shape of storage tanks, stills, asphalt tanks, acid tanks, etc. Some storage tanks approximate 3,600,000 gallons in capacity, while many mixing or agitating tanks exceed 120,000 gallons in capacity. Practically all refineries receive their tanks and stills in the form of sheet steel bent to shape and delivered in sections. Pneumatic tools find a large use in riveting these tanks and stills together.

The Smelting and Refining Industries

In mining operations pneumatic tools, air hammers, drills, etc., find a wide use.

Agitation in connection with leaching and dissolving of ores is accomplished with compressed air to advantage since there are no moving parts to be affected by acid fumes.

Many roasting and smelting furnaces, kilns, etc., require strong draft. For this purpose air compressors are generally used.

In making up and in the agitation of electrolyte, metal refineries employ air. Pneumatic hoists present an ideal method of hauling heavy electrodes as well as heavy filter press plates.

Smelters and metal refineries require much steel plate construction in the shape of tanks for cyaniding, leaching and precipitating. Furnaces are generally of steel plate construction lined with refractory material. Pneumatic tools are employed for riveting this steel plate work as well as lining the converters, furnaces, etc.

Metallurgical furnaces are generally water jacketed, requiring steel plate work which needs to be maintained in the best of repair.

Compressed Air in the Fertilizer Industry

Phosphorus, nitrogen and potassium are by far the most important constituents of fertilizers. Phosphorus occurs generally as calcium phosphate, rich deposits of which are found all over the world. Natural mineral phosphate deposits are very hard, too hard for powdering and direct use as fertilizer. The phosphate rock is therefore treated with sulphuric acid, the calcium phosphate dissolved out and recovered by precipitation.

Mining of Phosphate.—The majority of large fertilizer concerns carry on their own mining and quarrying operations. Compressed air tools are much used for drilling and boring "Hard Rock" phosphate.

Manufacture of Superphosphate.—Raw phosphate is first reduced by milling to a very fine powder. Operations are accompanied by much dust. Compressed air is much used for the blowing and cleaning of electrical equipment, motors, etc., about a fertilizer plant. The powdered phosphate is treated with sulphuric acid in a mixer.

Enormous quantities of sulphuric acid are used in this industry and compressed air lifts are much employed in fertilizer plants. An ordinary method for removing acid mixtures from one vessel to another or for unloading incoming tank cars of acid is by providing two openings to the tank and forcing compressed air into one of them, thus forcing liquid from the other opening.

When the acid-phosphate mixture is completed with agitation, the mixer is discharged to a pit below, where the fluid material becomes solid and requires excavating. This work of excavating was formerly accomplished with pick axes, but mechanical appliances are now much employed, some of which are operated pneumatically.

The Acid and Alkali Industries

The use of compressed air for handling, elevating and transferring acids and alkalies is fast extending. This is due to the durability and flexibility of air lift systems. Air-lifts are less efficient than pumps, but their use obviates the necessity of moving parts.

Sulphuric acid plants employ the air lift system extensively, as do other industries requiring large quantities of acid, such as petroleum refineries, fertilizer plants, steel wire and tin plate plants, explosive and dye plants, etc. A large portion of the several million tons of sulphuric acid produced in this country every year is handled several times by air lift systems.

Compressed air is also much used in such plants for the transferring of acids by the pressure system. This is accomplished by providing two openings to the vessel and forcing compressed air into one of them, thereby forcing the liquid out of the other opening. Vessels constructed expressly for this purpose are on the market in the form of stoneware acid eggs, cast iron montejus, and acid resistant tanks, etc. This method is employed extensively for charging and discharging tank cars, tank-bodied trucks, stills, tanks, etc.

In alkali plants, compressed air performs much the same work as in acid plants. In electrolytic alkali plants, air is used for agitation of brine in preparing the electrolyte, and in many cases for pumping the brine from salt wells. Air aids in handling many of the process liquid; caustic soda, carbonate of soda, neutralizing acid, ammonia, etc.

In electrolytic plants, the chlorine obtained is much used for the chlorination of organic liquids such as benzol, etc., and for the chlorination of lime solutions. Compressed air presents a ready means of transferring these highly corrosive liquors.

Potash solutions are concentrated by blowing hot air through the solutions.

The Glass Industry

In the glass industry air is employed for many purposes, both at high pressures, as supplied by compressors, and at relatively low pressures, as supplied by fans and blowers.

What these uses are, and the conditions attending them may be more fully comprehended by reviewing the various operations involved in glass manufacture.

The principal ingredients of glass are silica (white sand), soda (soda-ash), and lime (limestone). Large quantities of coal and clay are required for furnaces and melting pots.

In the mining of silica and coal, fans and blowers are used for ventilation purposes. Compressors are used in connection with pneumatic drills, hoists, locomotives, etc.

The quarrying of limestone is now done with pneumatic drills to provide a method for disintegrating of limestone formation.

The manufacture of soda ash on a large scale requires the saturation of ammoniated brine with carbon dioxide at a pressure of 40 pounds and the aerating, agitating and transferring of liquids by means of compressed air.

The production of fire clay pots bears a most important part in glass manufacture. After a pot is formed from clay it receives a preliminary heating in a "pot arch" where a forced draft, obtained with compressed air, is required.

Furnaces in which the glass is melted in clay crucibles are known as pot furnaces, while those in which the glass is melted in a clay tank are known as tank furnaces. Both forms of furnace are usually of the "Siemens" regenerative heating type, which has proved most satisfactory and economical.

Natural gas, producer gas, or crude petroleum with compressed air are used as fuels. Burnt gases from the furnace are made to pass through the fire brick checker work flues which become highly heated. The direction of draft is periodically reversed, the heated checker work in turn giving up its heat to the incoming gas and compressed air.

Bottles are produced by a combination of mechanical pressing and blowing with com-

pressed air with the aid of bottle molds. In the Owens bottle machine in which the whole operation is done mechanically, the glass flows from a melting tank into one which, revolving, carries the molten glass to the machine. The machine sucks up sufficient glass to make the bottle and at the same time forms the neck. It is then carried to a mold in which it is blown to its final shape with compressed air. Tumblers, chimneys and other cylindrical articles are blown in a mold and then revolved in the mold to eliminate joint marks.

Large objects such as vats, jars and bath tubs are made by the Sievert process. Molten glass is cast on a perforated metal table, rolled out into a sheet, and clamped to the table which is then turned over. The hot glass sags and is then blown by compressed air injected through the perforation. A mould is used to give the desired shape. Pressed glass is made by forcing a metal plunger into a heated mold, the glass filling the space between the plunger and the mold. The plunger is operated by compressed air. Compressed air is also used in glass plants for sand blasts, air lifts, acid transfer, pneumatic tools, etc. Fans and blowers are used extensively for supplying cooled, conditioned air to the work rooms where operations are accompanied by intense heat.

Sizes and Construction Details of Compressors Employed

In glass blowing plants, both steam driven compressors and power driven compressors are used.

Compressors in these plants are usually designed for pressures ranging from fifteen pounds to 100 pounds.

The capacities and sizes of installations vary to conform with individual plant requirements.

Window glass and plate glass require practically the same ingredients. The "batch" or mixture of materials is charged only after the pot has been brought to the necessary high temperature by the blast.

Window glass is made by two methods—by "machine" or by "hand." The difference is in the blowing process. In making hand made glass the workman "gathers" the "metal" upon the end of a blowpipe and by blowing produces a large cylinder of glass.

Machine-made glass is made by immersing a blowpipe in molten glass, introducing compressed air by means of a flexible pressure tube, and gradually withdrawing the blowpipe from the molten glass. By carefully regulating the speed of withdrawal and the amount of air introduced cylinders of any length are made.

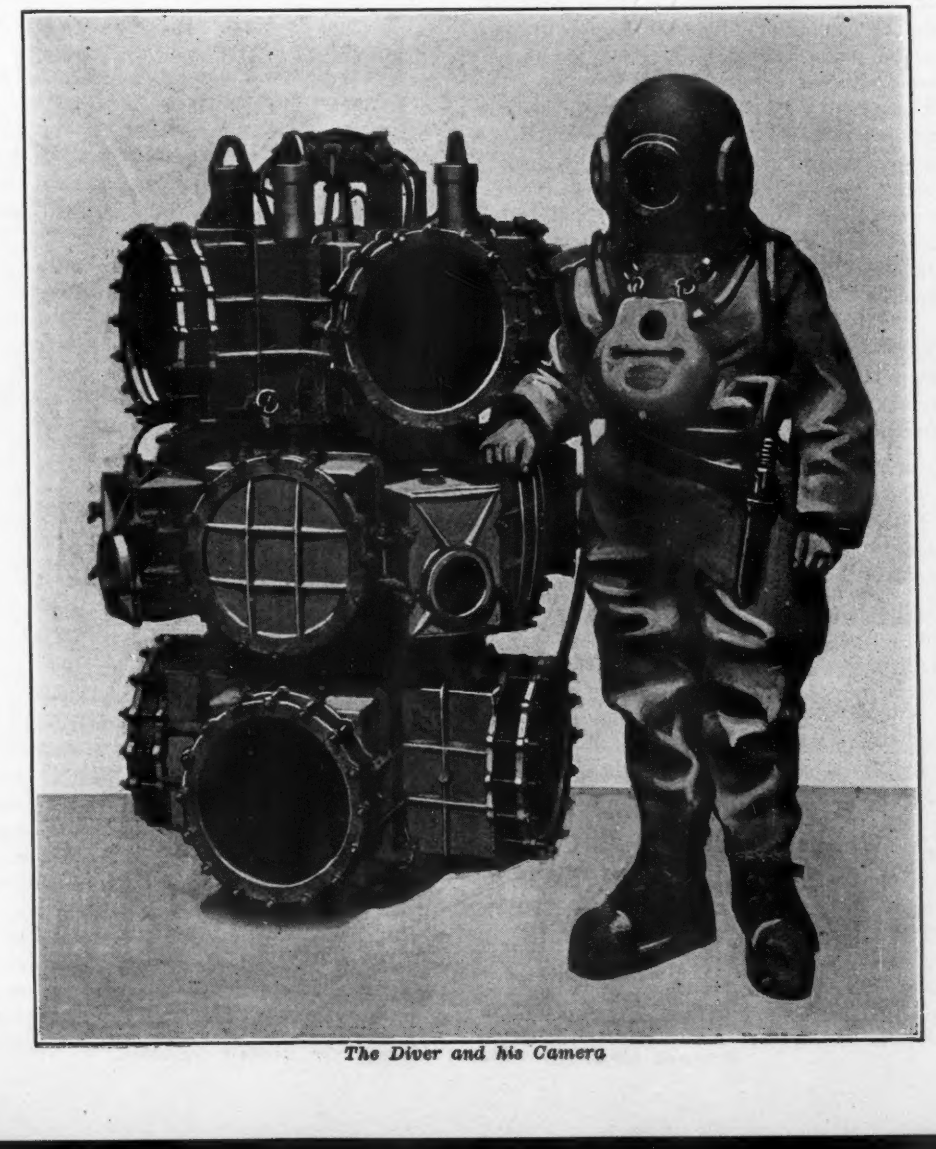
The intricate working of the blowing machine, the supply of molten glass, the air pressure, the rapidity of action, and the making of single or double thickness are controlled by a single operator. The blown cylinder is cracked off at both ends by spinning a string of hot glass at the proper place, or by the use of a wire wrapped around the glass and electrically heated, which causes the cap and crown to break off clean. The cylinder is then split lengthwise.

The cylinder is then placed in a flattening oven and as the heat increases and as the glass begins to wilt it is quickly smoothed out. The glass is then worked in an acid bath to wash off all dirt in preparation for cutting.

A SUBMARINE CAMERA

Before the retreat from the Lens district the Germans not only flooded the coal mines, but laid booby traps in them, says a writer in *The Engineer,* London, with the result that when operations were begun for the recovery of the mines, a number of serious accidents occurred, which greatly retarded reconstruction. The French Government, in order to avoid as far as possible a repetition of these accidents, decided to use a submarine camera for taking photographs under water, to ascertain where the lining of the mine shafts had been punctured, and to ensure that everything was safe before sending divers down. Siebe, Gorman & Co., Limited, of London, were commissioned to make the apparatus, of which we here give an illustration. The apparatus measures over all 3 ft. 4 in. by 3 ft. 4 in. by 4 ft. 9 in. high, and weighs about 15½ cwt. It consists of three main gun-metal castings, bolted together. The upper and lower castings are each formed with four water-tight chambers, each of which contains a mercury vapour lamp giving 3000 candle-power, or 24,000 candle-power altogether. The middle casting comprises four chambers which contain the lamp resistances, and four smaller chambers, which contain the cameras. A cable junction box and four lifting eyes are fitted on top of the upper chamber. The lamps are of the quartz or silica type, and were supplied by the Westinghouse Cooper Hewitt Co., Limited. The mercury vapour is contained in a quartz vessel having an overall length of about 9 in. The lamps operate in parallel on a direct current supply of 200 volts at a current consumption of 3½ amperes. As the candle-power of each lamp is 3000, the efficiency is in the neighborhood of ¼ watt per candle-power. The light from the lamps is extremely actinic, and the photographic effect, it is claimed, is equal to that of other lamps using a very much higher current. The lamps have been made as simple as possible, so as to avoid all unnecessary complications, the tilting to start their action being effected by means of special levers, actuated by rods on the outside of the box. These rods and the leads to the lamps pass through stuffing-boxes. The cameras are of a special box type, and are fitted with "behind lens" shutters which are electrically controlled. A very wide angle lens is employed.

Judge Gary of the United States Steel Corporation is abroad conferring with American and French financiers. Judge Gary is also deeply interested in the efforts of the League of Nations to solve European financial problems.

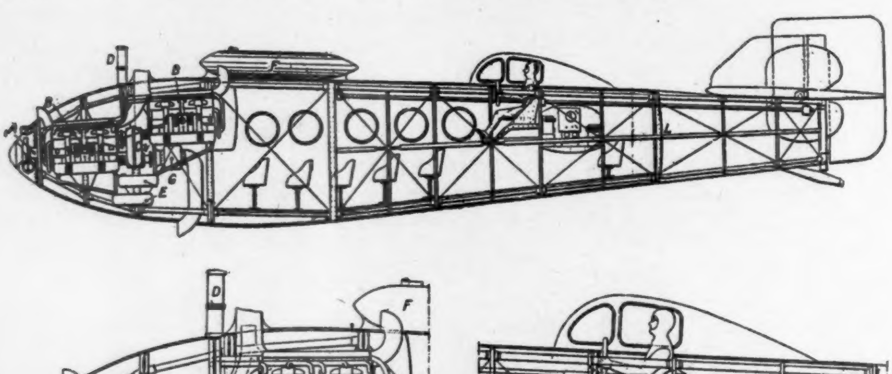


The Diver and his Camera

SPECIAL EQUIPMENT FOR HIGH ALTITUDE FLIGHT

THE PHYSIOLOGICAL effects of ascents to high altitudes are now fairly well understood, and in their aeronautical bearing according to the *Engineer*, London, have been made the subject of considerable research by the medical officers attached to the air services of this and other countries. For those requiring a knowledge of this matter we would recommend a paper, "Some Physical and Psychical Effects of Altitude," read last November by Dr. C. A. Swan before the Royal Aeronautical Society. Further interesting information on the same subjects is to be found in an article entitled "La Vie et les Voyages aux Trés Hautes Altitudes," by Dr. Guglielminetti, which appeared in the issue of our contemporary, *Le Génie Civil* for March 20th. This article possesses additional interest by virtue of the fact that it illustrates and describes a proposed Bréguet passenger aeroplane provided with a completely enclosed fuselage, within which the passengers, the crew, and the engines are accommodated, and within which the air pressure at all altitudes is maintained at the ground level value by means of a pump. With this arrangement not only are the occupants of the machine practically unaffected by the rarefaction of the air at very high altitudes, but the engines are likewise supplied with their full quantity of oxygen at all heights, while as an additional advantage the compression and decompression reaction on the passengers and crew resulting from a rapid descent or ascent are avoided. The fuselage, it will be seen, is, so far as the conditions prevailing in its interior are concerned, quite comparable with the body of a submarine, except that whereas the latter may have to withstand an external pressure of three or four atmospheres the fuselage skin has to withstand an internal pressure of not more than half an atmosphere.

The Bréquet high-latitude biplane fuselage is, as shown in the engraving, equipped with four Bréquet-Bugatti motors B on the system exhibited at the Paris Aeronautical Salon last December. The total horse-power developed is 950. All four motors drive the one screw A, and should one or other of them develop a defect it is automatically cut out by a clutch C. The radiator is shown at D, the oil tanks at E, and the fuel tank at F. A turbo-compressor G, presumably of the Rateau type driven by the exhaust gases of the engines, draws in air from the outside and compresses it for the benefit of the crew and passengers and the engines to the value of the pressure at ground level. No information is given as to how the compressor is controlled to accommodate the increase of compression ratio required as the height increases, nor is it stated whether any allowance is made for the fact that as the height is increased the percentage of oxygen in the air falls off perceptibly. The fuselage is made of metal throughout and is air-tight from the nose backward to the bulkhead L.



Proposed completely enclosed fuselage for Brequet aeroplane.

NOVEL PRACTICE IN DRIVING A TUNNEL

The following novel method of driving a tunnel heading is practiced in the Nordhausen mining district of Germany. Its success must evidently depend largely upon the character of the rock. Instead of following the usual practice of driving two or three shot holes inclined toward each other in the centre to unkey the surface of the work, the holes are bored quite close together parallel with the axis of the drift and locally known as "canon-shots." These are arranged and fired to make a hole of no great diameter in the centre of the face by crushing the rock. Then a ring of shot-holes is bored around this central opening and fired. This removes a considerable mass of rock, thereby greatly enlarging the central opening. Another ring of holes, more widely spaced, clears the face. The novelty consists in the closely situated central crushing holes. Being so near together, it is not necessary to have a primer and fuse in each. The concussion of one shot is sufficient to fire the rest. The resulting face of the heading is left flatter and in better condition for starting the next drive.

AIR FOR STEAM WHISTLES

In the majority of steamships the whistles or buzzers which are employed to give warnings to other craft are situated near the top of the smoke stack, high up above the boiler, and operated by a lanyard from the bridge which actuates a valve just at the base of the whistle itself. It follows therefore that there is a long length of steam pipe which however well lagged it may be, is always exposed to atmospheric temperature, and in which a certain amount of condensation must continuously occur. This, in itself, is an uneconomical procedure, but it has the additional disadvantage that when the whistle is blown after a long period of silence a large quantity of water has to be first cleared through the whistle, so that its response is often neither prompt nor clear, as every traveler has observed. In high latitude in winter time the ordinary type of steam whistle has been known to freeze up, necessitating thawing out before it could be used. An improved arrangement places the steam valve at the base of the pipe instead of at the top, so that the whistle pipe only contains steam when the whistle is actually being blown. Control is, of course, by means of a lanyard from the bridge, although electric controls have been devised so that the whistle is automatically operated at definite intervals and for a definite time, such as is necessary when steaming in foggy weather. Our lightships are now generally provided with oil-engine-driven air compressors and receivers of sufficient capacity so that they are always and instantly ready to blow in case of sudden fog or other emergency, and our steamships might take a lesson from them.

ELABORATE ELECTRIC POWER ECONOMY

A leather factory, as recently described in *Elektrotechnische Zeitschrift,* uses a waterwheel of about 30 kilowatts (40 horsepower) for driving a mill, and at times of light load employs the excess of available power to drive an asynchronous generator supplying electric energy to an overland supply system. When an overload occurs the generator reverses its action and runs as an induction motor taking its supply from the electrical mains. Automatic appliances are installed to control the action of the plant. A direct current machine is coupled with the asynchronous machine and has the function of charging accumulators and of running pilot lights. If the public supply fails while the mill is shut down an automatic switch causes the direct current machine to be loaded by a water resistance, thus preventing the waterwheel from racing.

The Phoenix Rubber Co., local distributors for the Kelly-Springfield tires in Phoenix, Ariz., will shortly install a 250-pound capacity automatic air compressor in order that the public at large may have an adequate supply of compressed air obtainable at a central location. This installation at the company's store, First and Monroe Streets, will be a great convenience to autoists who are in need of air any time of the day or night in the down town section.

Old vs. New Methods of Limestone Quarrying

Advent of the Modern Hand Hammer Drill has Revolutionized Methods—Improved System of Laying Track and Use of the Caterpillar Shovel Add to Production

By G. W. Morrison

Fig. 1—The Ogdensburg quarry, Ogdensburg, N. J., showing the working face after a blast. The drilling was done in this way by hand hammer drills. The holes can be clearly seen in the background.

FOR MANY years it has been the custom to use the churn type of well drill for breaking down the face of limestone quarries so that the stone could be handled by steam shovels. This method of drilling was thought to have advantages over previous tripod drilling methods, because in that way a large diameter hole could be drilled to a total depth of 80 to 100 feet. However, an average day's drilling was from 10 to 30 feet of hole per day. The practise was to drill a number of these holes and spring them, after which they were loaded with a large quantity of dynamite which in previous days did not figure so heavy against their tonnage, as the explosives could be bought at a cheap figure.

This method had the advantage of throwing down large quantities of rock, but also had the disadvantage of breaking it into very large sized stone, most of which had to be re-drilled and blasted to make them of a size that could be handled by the steam shovels and crusher.

The advent of the modern powerful hand hammer drill of a size suitable for drilling holes to a depth of 20 feet or more, such as the Ingersoll-Rand DDR-13, has to a large degree revolutionized the method of working limestone and other similar quarries.

In using this type of drill an operator has little trouble in drilling 250 feet of hole in limestone, in an average working day. These holes are usually drilled to a depth of 20 feet on from five to six foot centers, which gives an excellent distribution of explosives when holes are properly loaded, and breaks the rock up in such a manner to require much less plug hole drilling than is required by the older method, and reduces the drilling operation to a one man proposition.

One of the accompanying illustrations, Fig. 1, shows rock blasted down at the Ogdensburg Quarry, Ogdensburg, New Jersey, owned by the Wharton Steel Company, Wharton, N. J. The drill holes can be clearly seen. The plug drilling is done by BCR-430 Jackhamers, which average from 200 to 300 feet of hole per day.

This new method of drilling breaks the stone small and makes it possible to bring the loading tracks closer to the face, because blasting is done on a smaller scale but at more frequent intervals.

Quarrying Different Kinds of Rock with Hand Hammer Drills

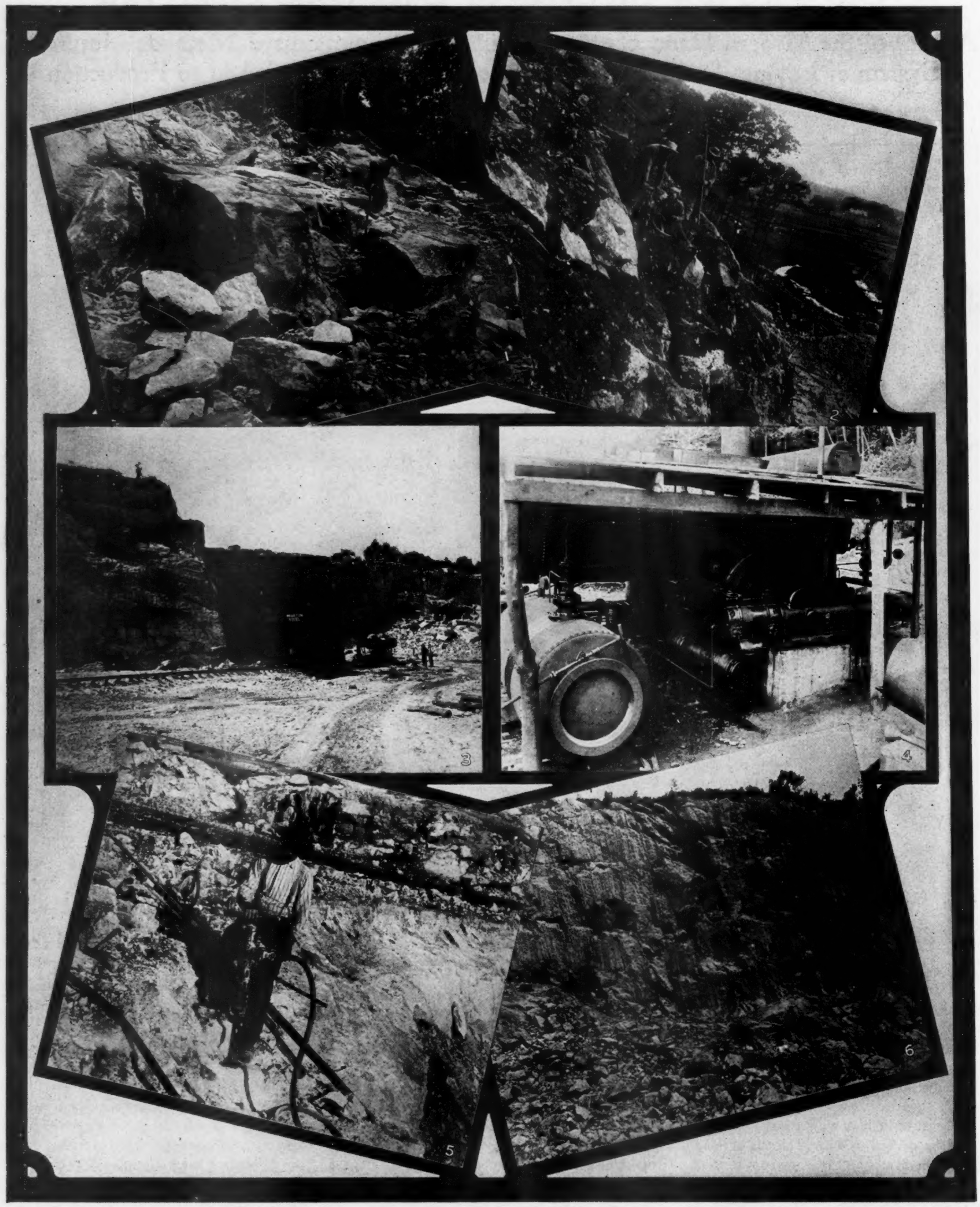


Fig. 1—Drilling trap rock with BCR-430 "Jackhamers," Howland quarry, Rockaway, N. J. Fig. 2—DDR-13 in use in Howland quarry, near Rockaway, N. J. Fig. 3—Ogdensburg quarry of Wharton Steel Co. Fig. 4—Temporary compressor installation on concrete foundation. Fig. 5—DDR-13 drills in use in another large limestone quarry in this district. Fig. 6—Bethlehem Mines Corp., McAfee, N. J., limestone quarry which is worked with DDR-13 drills, benches being about twenty feet high.

The efficient handling of rock depends upon a number of factors, the most important of which is the arrangement of track, while a firm road-bed, uniform gage and elimination of heavy grades also have considerable effect upon the results.

The system of track laying must be modified in order to suit conditions. In these quarries where steam shovel loading is employed, the system is ordinarily simple because the loading is conducted at only a limited number of places at one time.

The system of tracks used for many years in the majority of quarries consists of a main track in front of the crusher from which a series of spurs branch off and run up to the face of the quarry. Figure No. 2.

At the Ogdensburg Quarry, Mr. T. G. Straker has worked out a system of circular or loop tracks which has worked out very well in practice. This is shown in Figure No. 3. It does away with a great deal of switching and backing out of loaded cars, and also makes possible a much more constant use of the locomotive. It is also easier to keep the track up to the working face. Another very great advantage is that it greatly reduces the number of frogs and switches. With this new system there is not nearly so much danger of derailment and the consequent tying up of the entire quarry. When a derailment does occur the working face can be reached from the other side of the loop.

With Mr. Straker's system a new stretch of track is laid closer to the working face and connecting at both ends to the existing track, as the work progresses when there are more sidings than needed for car storage and switching those farthest from the face are torn up and re-laid closer to the work.

Instead of the ordinary steam shovel operating on the tracks Mr. Straker uses a caterpillar shovel, which not only does the stripping but also the loading. See Fig. 3, page 9864. This can be moved readily to any position without the necessity of laying tracks for it. Its caterpillar feature makes its operation very flexible and it has been used successfully in connection with excavation and in place of a derrick when placing heavy machinery, such as air compressors.

The crusher at this plant is driven by a Nordberg Stumpf Uniflow Steam Engine which operates condensing in connection with an Ingersoll-Rand Low Level Multi-Jet Condenser.

This quarry is operated by two Ingersoll-Rand air compressors; one, a Balance Piston Valve, 20-inch stroke cross compound unit with a two-stage air end and the other a straight line single stage 12-inch stroke balance piston valve machine. These compressors are operated condensing by a Multi-Jet condenser, similar to that used with the crusher engine.

Cameron piston pumps take care of the condensers and the boiler-feed for all engines and compressors in the quarry, and in the power house; a unique feature in that hot water is supplied to the engines throughout the quarry. This results in considerable fuel saving.

The drilling is done by Ingersoll-Rand Jackhamers and Waugh Dreadnaught Drills.

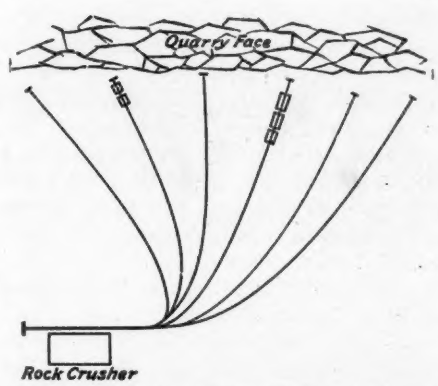


Fig. 2.—System of tracks which has been used for many years past.

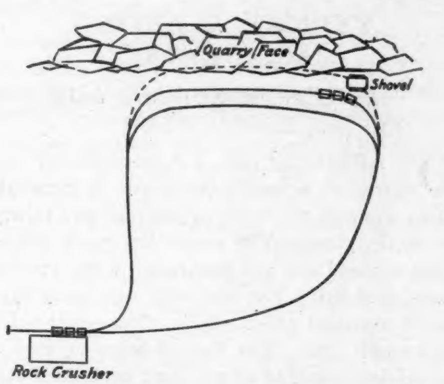
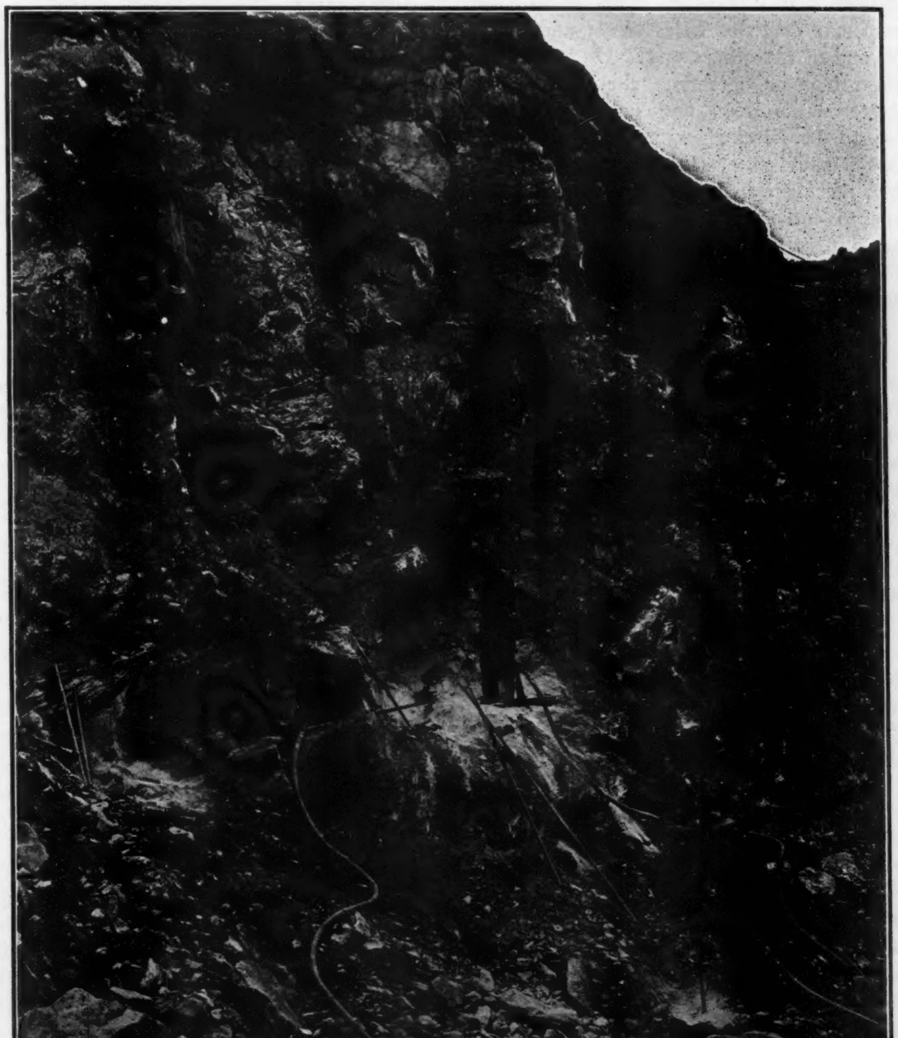


Fig. 3.—Loop system of tracks in use at Ogdensburg quarry.



Hand hammer drills at work at Bethlhem Mines Corp. limestone quarry.

The Bethlehem Mining Corporation is making very extensive use of this new method of drilling in several of its limestone quarries. See Fig. 6, page 9864, showing their quarry at McAfee, N. J., which is worked in 20-ft. benches. The drilling is done with DDR-13 Drills.

The trap rock quarries are also using the "Jackhamer" very extensively in preference to the churn drill. Illustrations, Figs. 1 and 2, page 9864, show one of these "Jackhamers" at work at the Howland Quarry at Rockaway, New Jersey. The stone being taken out is being used in the construction of the new sea wall which is being built just off the Atlantic coast.

A small shipment of coal left the pits at Lens, France, recently. This is the first that has been taken out of Lens mines since they were flooded by Germans during the war.

A company known as the American compressed Air Motor Co. has recently been incorporated with a capital of $100,000.

TYPICAL BLASTING ACCIDENTS*

By OLIVER BOWLES and J. E. CRANSHAW

ON APRIL 19, 1920, a fatal explosion occurred in a limestone quarry in Pennsylvania, causing the death of six men and injury to three others. The conditions were somewhat unusual and are illustrated in the accompanying sketch. The shot that was being prepared consisted of six $5\frac{5}{8}$ in. churn-drill holes in a single row. The line of holes crossed a depression that had at one time been used for the bed of an inclined track. Thus, as shown, two of the holes were on a bench about 20 ft. higher than the other four holes. The approximate depth of holes No. 1 and 2 was 73 ft., and of the others 55 ft. On account of previous blasting operations the rock was in a shattered condition and hole No. 1 was found to be blocked with rock fragments so that it could not be loaded. It seemed desirable, therefore to load No. 2 with a heavy charge to compensate for the absence of a charge in No. 1. As the blast was a small one a blasting expert was not employed, though for all large shots it is customary.

A line of cordeau detonating fuse was placed in hole No. 2, no electric detonators being used in the hole. After 12 or 13 cases of 40 per cent. nitro starch powder had been poured into the hole in loose form, it was found that a space of only 17 ft. remained for tamping. It was decided that space for an additional case of powder might be obtained by tamping the charge. The tamping was done with a heavy plunger about 3 or $3\frac{1}{2}$ in. dia. and 10 inches long, made of lead and with an iron core and with an iron eye in the top to which a $\frac{3}{4}$ in. rope was attached, and weighing between 30 and 40 lb. This weight was intended for use in sinking explosive in wet holes, and not for tamping. It is estimated that the tamping had been continued at least ten minutes. The quarry superintendent had gone a considerable distance for a box of powder, returned, and reached a point about ten feet from the hole, when the charge exploded, instantly killing the man who was tamping and injuring the superintendent and the shovel runner who also was nearby. A group of men were bailing water from the holes in the lower bench, and the rock hurled down killed five of them.

In November, 1918, while a 70 ft. drill hole was being loaded with four by ten in. cartridges of 50 per cent. Nitro-starch powder at a cement quarry, a cartridge probably got caught crosswise in the drill hole. While attempting to clear the drill hole by the use of a tripod hammer, the explosive exploded prematurely. The tamping bar on this rammer was a wooden bar four inches diameter, and about 40 inches long, and at the time of the accident was probably being raised and dropped from five to six feet.

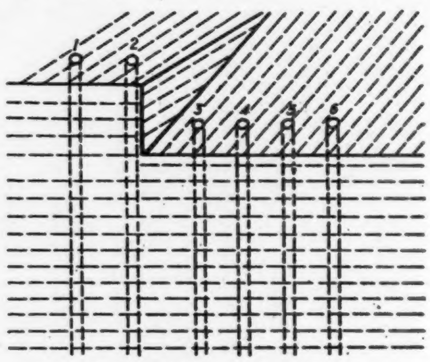
In December, 1912, at Balboa, Canal Zone, while a drill hole was being loaded with dynamite, a rock fell down the hole, closing it up. While an attempt was being made to dislodge the rock with an eighteen-foot steel drill, the powder in the hole exploded.

In October, 1912, near Empire, Canal Zone, a workman was tamping fifteen sticks of 45 per cent. straight nitroglycerin dynamite in a nine and one-half foot hole with a steel drill bar twelve inches long, weighing fifteen pounds, when a premature explosion took place.

In August, 1909, at Miraflores Locks, Canal Zone, while loading dynamite through an iron pipe, the iron pipe became clogged. While attempting to clear the pipe by tamping down hard with a wooden pole, the explosive detonated prematurely.

There are certain important conclusions to be drawn from the accident first described, to which careful considerations should be given by every quarryman.

The explosion seems to have been caused by hard tamping with a heavy plunger. With a smooth and regular drill hole such tamping might be conducted without accident, but in an uneven hole having jagged rock projections it seems likely that the heavy plunger impinged with sufficient force on a rock projection to generate the heat necessary to fire a thin film of explosive that may have covered it. Also the shaly condition of the rock in which the hole was drilled probably was a contributing cause. The small particles of rock loosened by the raising and dropping of the weight fell down into the explosive and were ground up by the tamping, making the explosive more sensitive to both friction and impact. Also, possibly some part of the iron constituting the core and eye of the plunger may have come in contact with siliceous rock projections and thus fired the charge. The use of a heavy tamping bar should therefore be carefully avoided.



Sketch of Quarry Conditions.

It is evident that for all purposes a wooden tamping bar should be used. The use of a wooden tamping bar has been urged repeatedly by the Bureau of Mines. Even with a wooden bar the tamping should not be continued beyond the minimum time necessary.

If it is found necessary to use a lead plunger to sink powder in wet holes, it should be provided with a copper rather than an iron eye. The subjecting of any explosive to frequent impacts with any heavy weight is dangerous practice.

A circumstance of extreme importance, is that it resulted in undue loss of life, was the employment of men on a lower ledge adjacent to a face back of which explosive was being placed. The holes of the lower bench should have been loaded first and all workmen removed from the lower bench before loading hole No. 2. Under such circumstances the premature explosion would have resulted in one fatality and two injuries rather than six fatalities and three injuries. While it is unusual to have a single line of holes occupying two benches, the general principle should be followed that workmen should never be allowed at the base of a quarry face after loading has begun, and the presence of workmen on the rock area between the line of holes and the face should be avoided as far as possible.

Every quarryman will observe that the conditions surrounding this shot were quite unusual, and it seems desirable to point out that accidents are much more likely to happen under unusual circumstances than under familiar conditions. Extraordinary conditions result in unusual activities, and the latter involve greater risk. Quarry operators should, therefore, give more careful supervision to blasts of unusual character than to regular blasts where all operations are standardized.

The Bureau of Mines has pointed out that the employment of thoroughly competent blasting experts is to be recommended. Such experts are employed for large shots in the quarry under consideration, but it seems advisable to extend this practice to include all primary blasts.

Quarrymen should familiarize themselves with the various safety rules promulgated by the Bureau of Mines and should endeavor on every occasion to put them into practice. Such rules are contained in various publications, which may be obtained upon application to the Director of the Bureau of Mines, Washington, D. C.

*U. S. Bureau of Mines.

THE DEADLY SIMOON EXPRESS

Men die in the desert from the effects of the simoon, a strong, hot and very dry wind. The explanation offered according to the *Journal Royal Meteoral Soc*, is this: "Because, therefore, the bodily gain of heat by convection from the air increases as the strength of the wind increases, and because the human body cannot perspire above a certain maximum rate, it is easy to see that to each air temperature above blood heat there must, theoretically, at least, correspond a certain critical value of the wind velocity, which, if exceeded, must produce a net gain of heat to the body. Also, the lower the air temperature the higher will be the critical wind velocity at which conditions become unlivable. Under actual atmospheric conditions this limit appears never to be exceeded except in an exceptionally hot and dry wind."

According to the Journal of Commerce, the Bethlehem Shipbuilding Co. is negotiating for the purchase of Pulsey & Jones yard to be used on repair work after adding dry docks and marine railway.

A PNEUMATIC PUSHER FOR COAL MINE CARS

At the main hoisting shaft of the Silver Creek colliery of the Philadelphia & Reading Coal & Iron Co. are two shaft stations with ingeniously simple arrangements for operating. At one of these stations compressed air renders conspicuous service as is seen in Fig. 2. The illustrations here given, as also the description, are taken from an interesting article by Dever C. Ashmead in *Coal Age*, recently.

The plan of the station here spoken of is shown in Fig. 1. Pneumatic locomotives place the loaded mine cars on the loaded track so that the first car of the trip can be reached by the pneumatic pusher. This loaded track is 320 feet long and perfectly level. If some of the cars from the previous trip have not been sent to the surface, and are standing on the loaded track, the new trip of loaded cars is coupled to those remaining.

The pusher is a long cast iron cylinder with a piston operated by compressed air. The cylinder is composed of three sections bolted together, each section being cast with wings in the middle of it by which it is secured to the roadbed. The end of the long piston rod is so arranged that it will engage the end of the mine car and when the air is admitted to the cylinder the piston is pushed out and the cars are driven forward, the travel of the piston being twelve feet. When the cars are pushed forward the maximum distance, the first car stands on a grade of three per cent., and is at a distance of 30 feet from the shaft.

When it is desired to load one of the mine cars on the cage the first and second cars are uncoupled from each other and in consequence the first car, which is standing on a three per cent. grade, moves forward by gravity and runs onto the cage, kicking off on the other side the empty car which is standing there. The empty car then passes down a 4.36 per

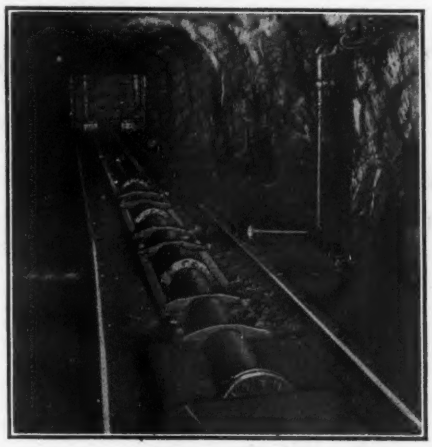


Fig. 2—Pusher cylinder with valves and piping.

cent. grade to a kick-back, which throws the car onto the empty-car track. For a distance of 36 feet this track is on a down grade of 1.9 per cent., but it changes at the end of that distance to a 1.29 per cent. grade against the empties. After rising on this grade for 272 feet it joins with the loaded track.

Sufficient speed is given to the car when it leaves the kick-back to carry the car past the end of a pusher for empty cars located at the point of changed grade. Fig. 2 is really a photograph of this pusher, but the one pusher which moves the loaded cars is of exactly the same construction. As soon as the car reaches the end of the pusher it is pushed up the slight grade until it is close enough to couple it with the preceding car. A sufficient number of empty cars are spragged to prevent the empty cars from running back down the grade. As the cars are coupled to one another as fast as they arrive they are ready for coupling to the mine locomotive. Hence they can be hauled to the mine workings without further delay. Just enough sprags are used to keep the cars from moving back by gravity, but not enough to have any great effect on the pusher.

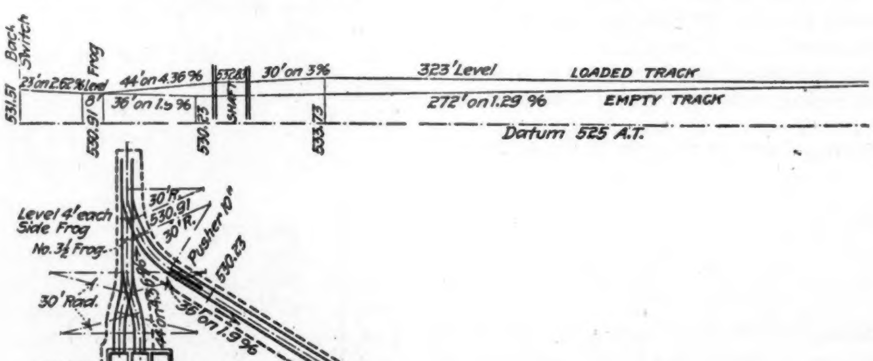


Fig. 1—Plan showing location of pneumatic pusher.

ANOTHER NEW "JACKHAMER"

Another "Jackhamer" has just been brought out by the Ingersoll-Rand Company, 11 Broadway, New York. It is known as the "DCR-13."

This completes the "Family of Jackhamers" manufactured by this company. The others are—the "BAR-33," 21 lbs., the "BBR-13," 36 lbs., the "BCR-430," 41 lbs. and the "DDR-13," 70 lbs.; altogether there are five sizes and thirteen (13) types.

This Company now claims to have a "Jackhamer" for every hand hammer rock drilling job

The new "Jackhamer" weighs 55 pounds. It is rated to drill holes up to twelve (12) feet deep rapidly in hard rock and it will fill all the requirements of a medium weight "sinker"

The New Jackhamer.

or down hole drill. Hence it will be welcomed for shaft sinking, quarrying, road-building, prospecting, developing, etc.

The "DCR-13" is extremely simple and sturdy. It is designed to withstand the most severe uses encountered in the class of work for which it is built.

The features most worthy of note, are:

All Steel Construction—Steel Drop Forgings or bar stock being used exclusively and specially heat treated.

All Bolted Construction.

Powerful Automatic Rotation—Relieving the operator of this fatiguing part of the work.

Spring Retained Front-Head—Takes up shocks that otherwise fall on the machine.

"Spool Butterfly" Valve—Operating on the well known "Butterfly" principle.

"Handy" Hole Blowing Device to keep the drill hole clear.

Renewable Bushing in Rotation Sleeve.

Automatic "Heartbeat" Oiler and grease pockets in handle and fronthead.

These drills are furnished for drilling dry holes (DCR-13) and wet holes (DCR W-13). Although they are usually used unmounted as sinkers, they may also be supplied with the "JC-11" Mounting for development or light drifting work.

Technology of Air as a Power Medium

IV. HOT AIR ENGINES—Continued

The Interconversion of Heat and Mechanical Energy, with Air as the Working Medium, Produces Alternate Isothermal and Adiabatic Expansions and Contractions as Illustrated in the Stirling and Ericsson Distinctive Types of Hot Air Engines

By Jacques S. Negru

THE CLASSICAL method by which Carnot in 1824 demonstrated graphically the working of a heat engine has even today the same unique instructive value as when first presented. It is therefore quite indispensable when dealing with engines to first outline the principle of Carnot's cycle for an ideal reversible heat engine as applied to hot air engines.

Fig. 19 represents schematically Carnot's engine and cycle. A cylinder E with walls of a perfect heat insulating material, a cover F of a perfect heat conducting material, a frictionless piston G, a heat supplying body I, a heat insulating body J and a refrigerator L constitute the ideal engine.

When the piston occupied the position (I) let the content of the space S be one pound of air, the volume, pressure and temperature of which are V_1, P_1, T_1 and geometrically defined by the point A on the diagram.

By submitting this air to alternate isothermal and adiabatic expansions and contractions the following four operations constitute a closed cycle:

1. Apply the heat supplying body I to the cover F. The air is thus heated and expands isothermally until the piston G reaches the position (II), during which time the heat supplied is integrally transformed into work so as to keep the temperature constant. The conditions of the air are V_2, P_2 and T_1 to which corresponds the point B. The external work during this isothermal expansion is represented by the area A B B_1 A_1 A, which according to equation (24) is

$$W_1 = R\ T_1\ l\ \frac{V_2}{V_1} \text{ food-pounds}$$

and its heat equivalent

$$H_1 = \frac{1}{778}\ R\ T_1\ l\ \frac{V_2}{V_1} \text{ B. T. U.}$$

The mass M being taken as equal to 1 pound.

2. Take away the heat supplying body I and replace it by the heat insulating body J. The air without receiving any external heat and without losing any heat by radiation expands adiabatically at the expanse of the internal energy of the air and the temperature drops to T_2 when the piston reaches the position (III). The volume, pressure and temperature of the air are now V_3, P_3, T_2 to which corresponds the point C. During this adiabatic expansion the work done is represented by the area B C C_1 B_1 B which according to equation (33) is $W_2 = \frac{R}{y - 1}\ (T_1 - T_2)$ ft. lb., and its heat equivalent

$$H_2 = \frac{1}{778}\ \frac{R}{(y - 1)} \times (T_1 - T_2) \text{ B. T. U.}$$

3. Take away the heat insulating body J and replace it by the refrigerator L. The piston is forced to the left when heat is developed but which is taken away by the refrigerator L as fast as it is produced, so that the air is contracted isothermally, i. e., at the constant temperature T_2. This operation is continued until the piston reaches the position (IV) when the volume, pressure and temperature of the air are V_4, P_4, T_2 to which corresponds the point D. During this isothermal contraction the work performed is represented by the area C D D_1 C_1 C, which according to equation (28) is

$$W_3 = -\ R\ T_2\ l\ \frac{V_3}{V_4} \text{ foot-pounds}$$

and its heat equivalent

$$H_3 = -\ \frac{1}{778}\ R\ T_2\ l\ \frac{V_2}{V_1} \text{ B. T. U.}$$

4. Take away the refrigerator L and replace it again by the heat insulating body J and continue forcing the piston to the left, when the contraction of the air is adiabatic. Heat is generated and this point D is so selected that when the temperature reaches the original value T_1 the position of the piston shall be in (I) which corresponds to the starting point A, i. e., the cycle shall close with the air at identically the same conditions of volume, pressure and temperature as at the start, namely, V_1, P_1 and T_1.

This is realized when the point D is located so as to have the ratio of the isothermal contraction $\frac{V_3}{V_4}$ equal to the ratio of the isothermal expansion $\frac{V_2}{V_1}$, i. e.

$$\frac{V_2}{V_1} = \frac{V_3}{V_4}\ r.$$

During the adiabatic contraction the work performed is represented by the area D A A_1 D_1 D, which according to equation (35) is $W_4 = -\ \frac{R}{y - 1}\ (T_1 - T_2)$ ft. lb. and its heat equivalent $H_4 = \frac{1}{778}\ \frac{R}{(y - 1)}\ (T_1 - T_2)$ B. T. U.

The net amount of work performed during the entire cycle is the algebraic sum of the partial works.

$$W = W_1 + W_2 + W_3 + W_4$$

$$W = R\ (T_1\ l\ \frac{V_2}{V_1} - T_2\ \frac{V_3}{V_4})$$

but, $\frac{V_2}{V_1} = \frac{V_3}{V_4} = r$, hence

$$W = R\ l\ r\ (T_1 - T_2) \text{ foot-pounds (37)}$$

which is represented by the area A B C D.

The total net change in heat during the cycle is the algebraic sum of the partial heats involved, thus:

$H = H_1 + H_2 + H_3 + H_4$. But, $H_3 = -\ H_1$ and $H_4 = -\ H_2$, hence $H = o$ (38)

Carnot's engine is reversible, i. e., the cycle of the alternate isothermal and adiabatic expansions and contractions when running in the direction A B C D A or A D C B A produces the same amount of work.

The thermal efficiency of the Carnot cycle is represented by the ratio between the heat equivalent to the work performed and the total heat furnished.

The only heat furnished during the cycle is

$$H_1 = \frac{1}{778}\ R\ T_1\ l\ r$$

and the heat equivalent to the total work performed is

$$\frac{1}{778}\ R\ l\ r\ (T_1 - T_2) \text{ B. T. U.}$$

hence the thermal efficiency is the quotient

$$E = \frac{\frac{1}{778}\ R\ l\ r\ (T_1 - T_2)}{\frac{1}{778}\ R\ l\ r\ T_1} = \frac{T_1 - T_2}{T_1} \quad (39)$$

This equation shows that the thermal efficiency can be improved or by increasing the temperature T_1, or by lowering the temperature T_2; but both these factors are limited in practice by mechanical considerations. Be-

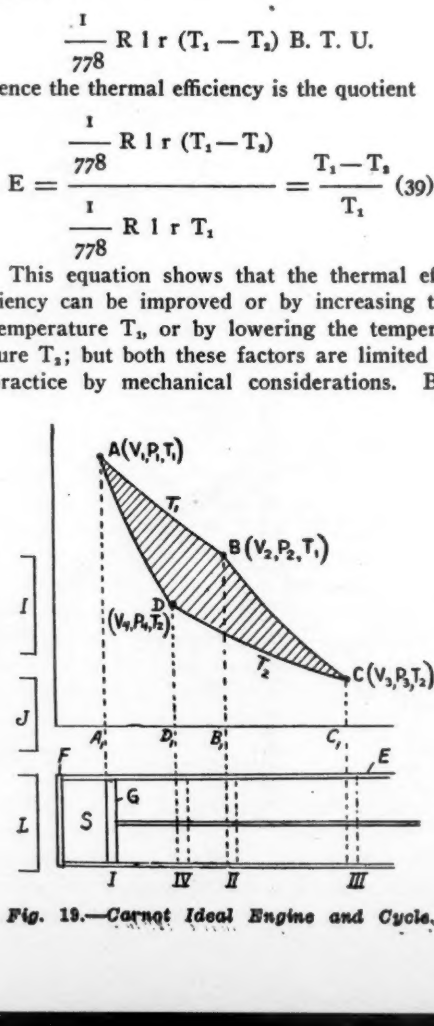


Fig. 19.—Carnot Ideal Engine and Cycle.

sides, by plotting the efficiency $\frac{T_1 - T_2}{T_1}$ for values of t_1 between 100 and 1,500 deg. F., the value t_2 being kept constant at 60 deg. F., it can be seen (Fig. 20) that there is not much gain by increasing the temperature t_1 over say 700 deg. F. This, then, may be considered the most practically convenient limit of temperature t_1 to which corresponds the absolute temperature $T_1 = 700 + 459.6 = 1159.6$; the maximum thermal efficiency under these conditions would be therefore

$$E = \frac{T_1 - T_2}{T_1} = \frac{(700 + 459.6) - (60 + 459.6)}{700 + 459.6}$$

$$= \frac{640}{1159.6} = 0.552$$

$E = 55.2$ per cent.

Typical Hot Air Engines

From what precedes it may be seen that the fundamentals of all heat engines are the realizations of reversible cycles as exemplified by Carnot's ideal engine.

The essential parts of a hot air engine are: Cylinders containing the air, which acts as the working medium, means to heat and cool the air, mechanisms for the performance of cycles of alternate isothermal and adiabatic operations and arrangements for the transmission of the resulting mechanical energy to perform work.

This class of engines is divided into different groups of which the most commonly encountered are: 1. Those in which the same mass of air is used and re-used, and 2. Those in which the air is used only once and then discharged into the atmosphere. To the first group belong the engines in which the air is heated by conduction through a metallic body, and the temperature changes take place at constant volume, whereas in the second group the air is heated or by conduction or directly in a furnace, and the temperature changes take place at constant pressure. When the air is heated directly in a furnace the working medium is in reality a mixture of the heated air with the gases of combustion.

Each of these main groups includes a series of types, but only very few have found practical application, although nearly all of them present quite interesting and some valuable features. It is not essential here to go into the details of describing them, and be it sufficient to dwell only on the technology of the two types the most widely known, namely: The *Stirling* which typifies the first group, and the *Ericsson* which typifies the second group.*

The Stirling Type of hot air Engine. A Stirling type of hot air engine is represented schematically in Fig. 21. In consists of a generator cylinder E^1 and a working cylinder E, whose volumes are respectively V^1 and V and provided with the pistons F^1 and F containing a heat insulating material, a furnace G, a refrigerator J (a double walled cover in which circulates cold water) and a regenerator R (a cylinder filled with wire gauze or pieces of sheet iron). The piston F is open to the atmosphere at the upper end and the piston rod Z is provided with mechanisms for the transmission of the power generated.

*For further details on the different types of hot air engines the reader is referred especially to the American and foreign patent specifications for this class of engines.

The working of the engine is as follows:

At the start the conditions of the air have to be V_1, P_1, T_1 as represented by the point A on the cycle diagram. The engine is now ready to perform cycles of alternate isothermal and adiabatic operations similar to those of the Carnot engine. Both pistons are at the bottom of their stroke. Heat is furnished to the air and the piston F^1 allowed to raise. The air below F^1 will expand isothermally and as the total volume remains constant the pressure above F^1 will increase and thus force the piston F upwards until the air conditions in E are V_2, P_2, T_1 as presented by the point B. The work performed during this isothermal expansion AB is according to equation (26) $W_1 = M^1 R T_1 l r$. During the upward movement of F^1 only part of the air in E^1 entered E and performed work; the other part returns through the regenerator to the cylinder below F^1 abandoning to the regenerator R part of its heat and when F^1 is at the upper end of the stroke the temperature of the air which was T_1 at the entrance m to the regenerator becomes T_2 at the outlet n. The total heat originally furnished to the air is thus used to perform the work W_1 and to heat the regenerator. This last quantity is equal to $M_1 C_v (T_1 - T_2)$ in which M_1 is the mass of air passing the regenerator, C_v the specific heat at constant volume, $T_1 - T_2$ the increase in the absolute temperature of the regenerator. If Q represents the total heat furnished,

$$Q = \frac{1}{778} M^1 R T_1 l r + M_1 C_v (T_1 - T_2) \quad (40)$$

$M^1 + M_1$ is considered to be the mass M of air in the apparatus, the air of the passages a, b, c and the regenerator is not taken into consideration.

When the pistons F^1 and F are at the upper end of their stroke the air above F^1 is cooled by the refrigerator J, the pressure and temperature in E fall with no work performed and the conditions of the air are then V_2, P_3, T_2 as represented by the point C. The pistons are now forced downwards. The volume of the air in C becomes V_1, the air $V_2 - V_1$ cooled by the refrigerator to T_2, and the pressure becomes P_4. These conditions of the air are represented by the point D. During this isothermal contraction the work spent is according to equation (28) $W_2 = - M^1 R T_2 l r$. In the same time the air from under the piston F^1 passes through the regenerator to the upper part and during this travel is heated at constant volume by the heat previously stored in the regenerator, namely $M_1 C_v (T_1 - T_2)$—assuming the efficiency of the regenerator to be 100 per cent—and when the pistons are again at the lower end of their stroke the conditions of the air below F are V_1, P_1, T_1 corresponding to the original point A. The cycle is thus closed and the engine ready to start another cycle, and so on.

It can be seen that the heat used during the isothermal expansion is recuperated during the isothermal contraction, but has been absorbed by the refrigerator, and that the heat absorbed by the regenerator during the upward stroke is recuperated during the downward stroke, so that the only loss of heat which occurs during the cycle is that absorbed by the refrigerator. This is the amount of heat per cycle which is to be newly supplied by the furnace.

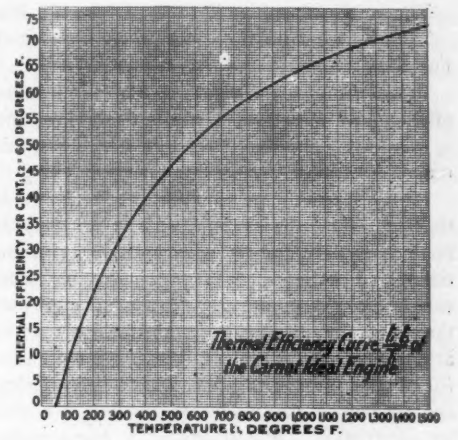


Fig. 20.—Thermal efficiency $\frac{T_1 - T_2}{T_1}$ of Carnot ideal engine.

The total external work performed per cycle is: $W = M^1 R T_1 l r - M^1 R T_2 l r$. $W = M^1 R l r (T_1 - T_2)$ foot-pounds which is represented by the area A B C D A. The heat equivalent to this work is

$$H = \frac{1}{778} M^1 R l r (T_1 - T_2) \text{ B. T. U.}$$

The total heat furnished Q being (40)

$$\frac{1}{778} M^1 R T_1 l r + M_1 C_v (T_1 - T_2)$$

in which the second member is entirely recuperated by the regenerator (assuming 100 per cent. efficiency), the theoretical maximum thermal efficiency of a Stirling cycle would be

$$E = \frac{\frac{1}{778} M^1 R l r (T_1 - T_2)}{\frac{1}{778} M^1 R l r T_1} = \frac{T_1 - T_2}{T_1}$$

the same as for the Carnot ideal engine. But in reality this is never the case because the efficiency of the regenerator is not 100 per cent. If its efficiency is x we have for the heat supplied to it $M_1 C_v (T_1 - T_2)$ and for that recuperated $x M_1 C_v (T_1 - T_2)$, when the total heat to be supplied is

$$\frac{1}{778} M^1 R l r T_1 + (1 - x) M_1 C_v (T_1 - T_2)$$

and the thermal efficiency of the engine would be

$$E = \frac{\frac{1}{778} M^1 R l r (T_1 - T_2)}{\frac{1}{778} M^1 R l r T_1 + (1 - x) M_1 C_v (T_1 - T_2)}$$

Other factors influencing the thermal efficiency are losses due especially to radiation and friction.

The range of values $T_1 - T_2$ is usually low.

The practical temperature limits for a stirling engine are 650 and 150 deg. F.

Practical tests have shown that the thermal efficiency of this type of engine is seldom over 25 per cent., about 30 per cent. being a maximum.

The Ericsson Type of Hot Air Engines. In the Ericsson type of engines the air may be heated—as mentioned above—or by conduction or directly in a furnace. In the latter case the air is bound to be contaminated with the gases of combustion, and its corroding action at the temperatures used is very harmful. Fig. 22 represents schematically an Ericsson type of engine in which the air is heated by conduction. It consists of a compressing cylinder E^1 (the air used is first somewhat compressed) and a working cylinder E, provided with the pistons F^1 and F containing a heat insulating material and having the same piston rod G which is provided with mechanisms for the transmission of the power generated, a compressed air receiver J, a furnace L and a regenerator R (a cylinder containing wire gauze or pieces of sheet iron). Valves m, n, o, p, permit the interconnection between the vessels as shown. Cylinder E^1 is open to

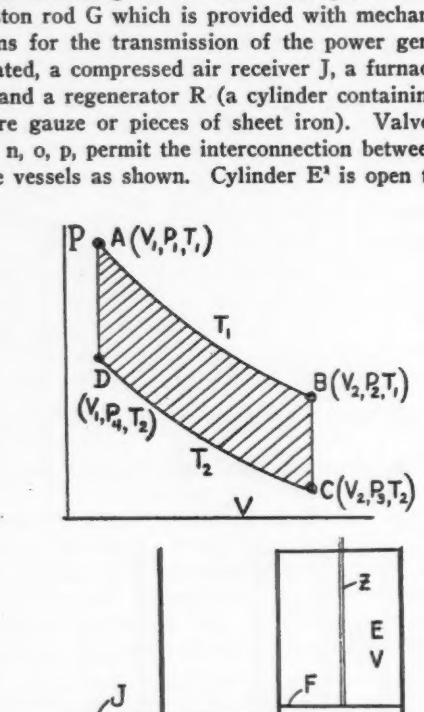


Fig. 21.—Schematic representation of a Stirling type of hot air engine and Stirling cycle.

the atmosphere at the bottom and cylinder E is open at the top. The ratio of the diameter of E^1 and E is usually ⅔.

The working of the engine is as follows:

At the start both pistons are at the bottom of their stroke, valves m and p open, hence cylinder N and S are under atmospheric pressure, valves n and o are closed, the air in J is compressed and the regenerator is hot (temperature T_1 absolute). The engine is started by closing the valves m and p and opening n and o. The pressure in S, N and J is thus equalized. Let P_1, V_1, T represent the conditions of the air in S, as represented by the point A. Close the valve n. Due to the fact that the area of F is greater than that of F^1, although the pressure in S and N is the same, the pistons will raise; air from J will enter S after passing the regenerator where it will be heated to T_1 and thus the air in S will be expanded adiabatically under constant pressure. This expansion will continue until the resulting increased pressure in N counterbalances the work of expansion in S, when the conditions of the air will be P_1 V_2 T_1 as represented by the point B. The heat equivalent for this expansion, and which was taken from the regenerator, is

$$M\ C_p\ (T_1 - T)\ \text{B. T. U.}$$

Valve n is opened and o closed; the pressure N and J is thus equalized. Heat the air in S and allow it to expand isothermally until the pistons are at the upper end of their stroke when the conditions of the air in S are P_2 V_3 T_1 as represented by the point C. The work corresponding to this isothermal expansion per unit mass of air is

$$R\ T_1\ l\ r \text{ foot-pounds}$$

Close valve o and open valves m and p, when N and S are open to the atmosphere, the pistons move downwards, the air from S escapes to the atmosphere, after having abandoned its heat to the regenerator. This adiabatic operation at constant pressure is continued until the air in S is under the conditions V_4, P_2, T to which corresponds the point D. The heat given up to the regenerator per unit mass of air is

$$C_p\ (T_1 - T)\ \text{B. T. U.}$$

(This assumes a regenerator efficiency of 100 per cent.)

Close valves m and p, open n. The pressure in J and N is equalized, the pistons continue to move downwards until they reach the bottom of their stroke when the valve o is opened and the air is at the original conditions V_1, P_1 T corresponding to the point A the beginning of the cycle. The work per unit mass of air during this isothermal operation is

$$R.\ T.\ l\ r \text{ foot-pounds}$$

The apparatus with the pistons at the bottom of their stroke, valves m and p closed, valves n and o open, regenerator at temperature T_1 absolute, and conditions of the air V_1, P_1, T is now again ready for another cycle and so on.

The net amount of work done is given by

$$M\ R\ l\ r\ (T_1 - T) \text{ foot-pounds}$$

which is represented by the area A B C D A.

The heat equivalent to this work is

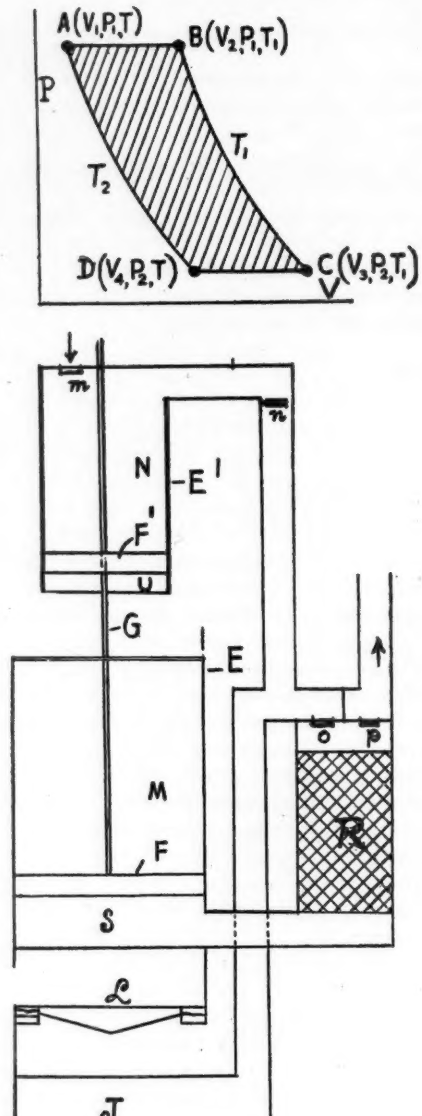


Fig. 22.—Schematic representation of an Ericsson type of hot air engine and Ericsson cycle.

$$\frac{1}{778}\ M\ R\ l\ r\ (T_1 - T)\ \text{B. T. U.}$$

Assuming the efficiency of the regenerator to be 100 per cent. the only heat to be furnished to the apparatus would be

$$\frac{1}{778}\ M\ R\ T_1\ l\ r$$

and the maximum thermal efficiency would be

$$E = \frac{\frac{1}{778} M\ R\ l\ r\ (T_1 - T)}{\frac{1}{778} M\ R\ l\ r\ T_1} = \frac{T_1 - T}{T_1}$$

With a regenerator efficiency x the total heat to be supplied per cycle would be

$$E = \frac{\frac{1}{778}\ M\ R\ l\ r\ (T_1 - T)}{\frac{1}{778}\ M\ R\ l\ r\ T_1 + (1 - x)\ M\ C_p\ (T_1 - T)}$$

Some engines of this type have no regenerator, in which case the maximum thermal efficiency is

$$E = \frac{\frac{1}{778} M R l r (T_1 - T)}{\frac{1}{778} M R l r T_1 + M C_p (T_1 - T)}$$

In practice losses due especially to radiation and friction have to be taken into consideration, and for this type of engines the thermal efficiency is at the most 25 per cent.

Although theoretically hot air engines—also called external combustion engines—offer great economic advantages over other types of heat engines (steam and internal combustion engines) they are not used industrially to any extent, due mainly to the facts that the range between the initial and final temperature is limited, that lubrication at high temperatures is difficult, and that the metal is soon burnt out. But the thermodynamics of air is now so well formulated and its theory so full of expectations on the practicability of its more efficient industrial application that, without being a utopian optimist, it might be foreseen that mechanical improvement in construction—especially the adaptability of a turbine type—will result in a wider and ever increasing use of hot air engines.

A LESSON IN EXPLOSIVE MIXTURES*

Gasoline vapor mingles with air in the same manner that water vapor does. At any particular temperature a definite proportion of water vapor will be found in the atmosphere if the latter is completely saturated, a condition that seldom exists. Usually the amount of water vapor is less, and the atmosphere is said to have a certain relative humidity, meaning that the saturation is incomplete and that more water vapor could exist in the air.

In a similar manner gasoline vapor mixes with air. The amount of vapor carried will depend on the temperature of the air and on other conditions. If gasoline is exposed to the air of a room for a long enough time, the air will contain, at a certain temperature, a fixed proportion of gasoline vapor which cannot be exceeded. For different grades of gasoline this value will differ. The author has worked out the values for four different grades. The results for a temperature of 17.5° C. (63.5 F.) are shown in the following table.

Proportion of different grades of gasoline vapor that will carry at a temperature of 17.5° C.

Grade of Gasoline.	Percentage of Gasoline Vapor
Cleaner's naptha	5.0
64° B. gasoline	11.0
69° B. gasoline	15.0
73° B. gasoline	28.0

It will be noticed that the air will hold almost six times as much of the vapor from the lighter gasoline as of the vapor from the heavier cleaner's naphtha. When these lighter and better grades of gasoline are heated, their vapors when a light is applied, flash and burn at lower temperature than do the vapors of the heavier grades. This difference does not imply that some gasoline is dangerously inflammable and that some is not. All grades are classed as highly inflammable and dangerous liquids. If one takes the cover off a full pail of tightly inclosed gasoline and applies a match to the surface, the gasoline flares up and continues to burn as long as the gasoline lasts. On the other hand, if one puts a few drops of gasoline into a small tightly inclosed pail, waits a few minutes, and then introduces a flame or an electrical spark into the pail, a violent explosion will most likely result. In the first experiment the vapor burned as fast as it came from the gasoline and mixed with the oxygen of the air. In the second experiment the oil vaporized in the pail and mixed uniformly with the air therein to form an explosive mixture, and upon ignition, exploded. In other words, when one hears or reads of a disastrous gasoline explosion, one may be sure that the explosion resulted from the mixing of vapor from the gasoline with air in the proportions necessary to form an explosive mixture. If a match or other means of ignition could be applied to pure gasoline vapor no fire or explosion would result, owing to the absence of air. For the combustion of gasoline, liquid or vapor, as is true of all combustible materials, oxygen is required.

How Explosives May Occur

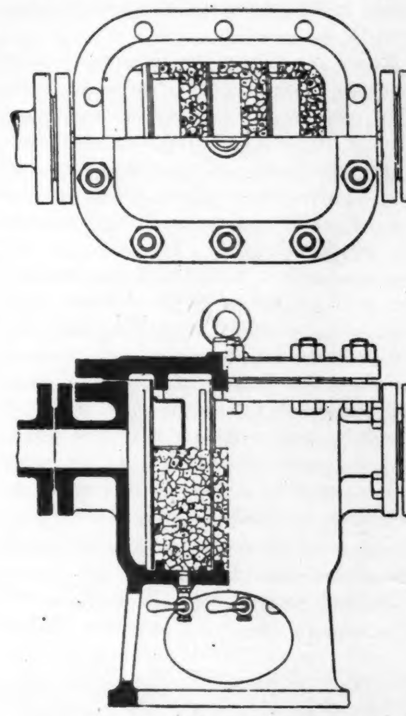
As with other gases and vapors, it is fortunate that before an explosion of gasoline vapor can occur, the exact explosive proportion of air must be present. The author found that in 100 parts by volume of air and gasoline, an explosion will not take place if there is less than 1½ or more than 6 parts of gasoline vapor. In other words, the explosive range is between 1½ and 6 per cent of gasoline vapor. Although this range of explosibility is narrow as compared with that of many other mixtures of combustible gases and air, yet the lower limit involves a very small proportion of gasoline vapor, indicating the great importance of not allowing even a little gasoline to be exposed in a room. If one gallon of gasoline that is sufficiently volatile were allowed to change completely into vapor simply by being exposed to the air in a room, and if the room were gas tight, this one gallon could make explosive about 2,100 cubic feet of air, the amount contained in a room measuring 10 by 10 by 21 feet.

In the actual use of gasoline such a condition is not found. Imagine that a person is filling an open pail from a larger tank, or is sponging a dress with gasoline from an open can. When the pail is first filled with the gasoline, a small amount of pure gasoline vapor is given off just over the surface of the gasoline. Just above this layer of pure gasoline vapor is a mixture of gasoline vapor and air, which at some point contains an explosive proportion of the two constituents. Farther away from the pail there will be a very small proportion of vapor, and still farther away no vapor at all, but just pure air. However, all the time the user of the gasoline is at work the vapor keeps forming, both from the gasoline in the pail and from the sponge and dress goods, rendering more and more air inflammable or explosive, until finally there exists a dangerous atmosphere, perhaps completely surrounding him, and needing only a source of ignition to envelop him in flames. Ignition of the gasoline vapor may take place even in a room adjoining the room in which the operator is working, and some distance from the gasoline. As the gasoline evaporates, more and more vapor is given off which mixes with air farther and farther from the gasoline and may, if the evaporation lasts long enough, travel to an adjoining room and perhaps be ignited there. Upon ignition a sharp flash will travel back through the room to the gasoline. Gasoline vapor is about three times as heavy as air, and in traveling from the gasoline will be present in greater proportion near the floor.

*Bureau of Mines, Tech. Paper 127.

AIR FILTER AND TRAP FOR COMPRESSED AIR LINES

The device shown in the cut has been in successful use at the Gneisenan Pit (Germany), and also in the structural work department of the Harpen Mining Company since 1914 without interruption. The air pressure, it is stated, is not affected by the insertion of the trap in the pipe line, as proved by measurements, which would be true only if the passages provided were of sufficient area.



Filter and Trap for air pipes

The filtering material to be seen in the plan and sectional elevation consists of small, angular, rough lumps of crushed flint, which the compressed air has to pass through on its way. According to a published description, the air arrives with great velocity in the first air chamber where it is deflected 90 degrees. It leaves the air chamber through an opening in the bottom and is blown through the interstices between the lumps of flint, rising into the next chamber. The flints in the water trap intercept all dirt and moisture, and the air emerges thoroughly cleaned and dried. As to the drying this can mean only that the actual water in its condensed form will be removed, with no effect upon the water vapor, which might still be present in the air up to the point of actual saturation.

RIVETING PLATES ON THE SHIP

By F. H. SWEET

A WONDERFUL thing is the building of a great ship. Even the onlooker feels a swelling of the throat as he moves about among the army of skilled artisans who are fashioning the leviathan. He has seen houses go up, sky scrapers, whole villages off-hand, perhaps, but they dwarf to insignificance beside this. Maybe he talks with the foremen of a dozen different trades as he wanders around, with a riveter who does not slacken work as he gives information in jerky sentences, with the manipulator of a pneumatic hammer, with men fitting in position monster plates with the help of machines seemingly imbued with human intelligence. When the onlooker goes away he carries new ideas that will remain with him for many a long day, and if it be possible he will return to that vessel again and again, or so it was with me.

For days I could hear the hammering, hissing, rasping, clanking, and dozens of other operating sounds of the skilled army, and marveled at the millions of rivets that were going into the fastening of the plates and frames. Later visits resolved the marveling into concrete and systematic facts, but none the less wonderful.

In some shipyards I found it the practice to ream each of the millions of holes after the work was assembled, both to remove the material stressed by the punching operation and to align the holes, thus avoiding later troubles in inserting the hot rivets. Thousands of these holes are so located that it is found more convenient to drill them after the work is assembled than to lay them out for punching previous to assembling.

The edges of all the thousands of plates comprising the shell, bulkheads and tanks of the ship—all the water-tight joints—must be cut to a smooth edge and calked to make a water-tight joint. Under our present conditions, almost all of this work is done with pneumatic tools.

Of course all the numerous riveted joints necessary in ship-work add hundreds of tons to the weight of the ship, due to the overlapping plates, liners, butt-straps, and other things. Many ways and means have been tried to avoid some of the extra labor all this involves. Plates have been made larger, reducing the number of joints. A system of "jogging" or offsetting the ends of the plates so that a joint may be made without filling pieces is used to considerable extent. But it hasn't lightened the work much. No general substitutes for rivets on shipwork are yet in sight.

Spot-welding and continuous welding of joints have been developed to a degree where it is practical for light work, but to date it has not been considered practicable to apply any of these welding processes to the extensive joining of heavy plates.

The requirements necessary to produce good tight rivets are as follows: The holes must be practically in line; the plates must be well bolted together; the rivet heads must be up against the plate; the rivet necks must fill the hole; the rivets must be hot enough to expand and fill the hole the entire length when driven; the holding-on device must hold the rivet firmly in place; the riveting machines must have sufficient power to form the rivet before it gets too cold to fill the hole. A rivet which is loose in the hole may be calked up so that it will pass the inspector's testing hammer, but such a rivet will not hold its estimated load under a breaking strain, and any large number of such rivets would lower the efficiency of the joint to a danger point.

There are two different ways of driving rivets; one is the one-man machine method, and the other is the two-man "hand gang" method using hand-hammers. Driving rivets by hand is a business that requires some natural aptitude and training, extending over considerable time and demanding much experience. A hand-gang is, therefore, likely to have had more experience and be more skilled in the business than the machine man. This is partly the reason why hand-driven rivets have in the past had a better reputation than the machine-driven ones. Given a husky man who knows his business, in combination with a good machine, proper air-pressure, a heater who will "get 'em hot," and a holder-on who will "get the heads up," and the machine man will do more work than the hand-gang, and it will be equally good. There are many places where it is not convenient to pipe the air to the job, or to rig up for a few rivets. In these places hand work is more economical.

In our recent operations hand work has been out of the question, for the supply of skilled workers has not been adequate. So with few exceptions, all of our new ships have been machine riveted. The "long-stroke" air hammer is the type adapted to the general run of riveting. Driving rivets with one of these hammers is a strenuous occupation, and calls for a strong man hardened by experience. The hammer weighs about 25 pounds and contains a solid steel plunger 1 1-16 inch by 2½ inches, which makes 600 or 800 strokes per minute. The length of the stroke varies for different hammers, and may be six, eight, nine or eleven inches. The vibration added to the weight increases the difficulty of holding and controlling the machine. In driving cone-head or button-head rivets, the head of the rivet helps to hold the machine in place while the rivet is being headed. In the "flush riveting" such as is required on the outside shell of a ship, the machine must be guided and controlled without this assistance from the rivet head, which is flattened until it is either flush with the surface of the plate or slightly convex.

Wherever cone-head or button-head rivets are to be driven and a convenient backing is available, the so-called "jam-hammers" may be used to advantage. These consist of a riveting hammer telescoping in an air cylinder in such a way that the hammer is thrust out against the rivet, the backing taking all the weight and vibration. Many records for fast work have been established with these machines. The work is likely to be uniformly good, as they strike a harder blow than the pneumatic hammers, which are held by hand. These machines may be opposed by the regular holding-on machines, or one jam-hammer may be used in the holding-on machine. The foreman should keep in mind that wherever the weight and vibration of the machine can be taken by some mechanical device, the operator is relieved of the hardest part of the work, and, other things being equal, more work should be done.

Where a sufficiently strong backing may be obtained behind the rivet, the best possible kind of work may be secured by steady pressure. Generally speaking, there are two kinds of machines used for this purpose; one comprises a yoke and a single cylinder and piston operated by direct hydraulic pressure, and the other is a pneumatic machine consisting of a yoke and cylinder containing a piston operated by air pressure. The pressure necessary for riveting is obtained by a system of toggers or levers.

To form a good rivet of the ordinary sizes (¾ to 1 inch) about 60 tons pressure is required, but full pressure of the machine, which may amount to 100 tons or more, is usually applied to all of the larger sizes indiscriminately. The yoke which carries the holder-on die must be sufficiently strong to withstand this pressure. If the depth of the yoke is sufficient to take in wide plates the weight becomes so great that the machine is made stationary and the work is carried to the machine. Up to a 20-inch or 30-inch gap, it is within limits to carry the machine to the work.

Very fast and satisfactory work can be done with these machines, but their use is limited to such work as can be spanned by the yoke, or such work as can be economically lifted and moved to position by the crane. A light yoke riveter of comparatively deep gap may be equipped with a heavy "jam-hammer" on one end and a holder die on the other, and drive the rivet by a great number of rapid blows rather than a single application of heavy pressure. This type has the advantage of lightness as compared with the pressure riveter, but is not quite as rapid and does not insure that the work will be pressed solidly together as does the pressure system. The ultimate strength of a joint riveted by heavy pressure is no greater than that of one riveted by hand or by an air hammer, but the pressure-riveted joint will stand a much greater strain before visible "slip" or yield occurs. The rivet-forming dies are simply replaced with a punch and die. For doing speedy work with these machines, it must be remembered that the time actually required to drive the rivets is small, and that delays occur in getting the rivets in the holes or shifting the machine; therefore, care should be taken to have every convenience provided to facilitate these operations.

Various methods of heating the rivets are employed, depending on the conditions. The foreman should make it a point to be certain that the rivets are being heated as fast as they can be used; if they are not, he should revise his method of heating. The common hand-forge serves the purpose where the speed of the work is limited for some reason, or if there are frequent delays. A "fire-pot" using hard coal or coke, and furnished with an air blast

from the compressed air hose, is quite a satisfactory device for heating rivets rapidly, but the rivets may be burned if there are frequent delays and care is not used in regulating the fire. The gas or oil furnace is adapted to conditions where a great many rivets are used. The heating furnace should be set up where it will be convenient to the job. If ventilation or other conditions make this impossible, convenient arrangements to pass the rivets should be provided. Oftentimes a length of two-inch pipe makes a good tube through which the rivets may be dropped by the heater and guided to the holder-on, lower down in the ship.

The work should not be turned over to the riveters until it has passed a careful inspection to insure that it is properly bolted up. The plates must be in absolute contact; otherwise the rivets will not be tight. The bolts should be so arranged that the riveters can remove them with the minimum amount of trouble and delay. The time of a bolting-up gang is worth less per hour than that of a riveting gang, and it is therefore economy to have them do as large a share of this work as possible. If the bolts are too long or put in without washers, the riveter is delayed while he unscrews the nut the entire length of the bolt. Where the thread is right, the nut once loosened can easily be taken off with the fingers. Sometimes in drawing up the work the plates shift and bind the bolts in the holes. In such cases the bolting-up gang should remove the bolt and shift it to the adjacent hole, either reaming or pinning the bad hole until a rivet will enter. Otherwise the job will have to be done by the riveter.

POWER FROM THE TIDES

The industrial utilization of tidal power is shortly to be put in operation at La Landriais, near St. Malo, on the River Rance.

The scheme depends on the construction of four basins at different levels, each being used for power generation at different states of the tide, according to a cycle based on the Decoeur cycle described before the Académie des Sciences in 1901. The four basins will have an aggregate area of some 50,000 acres, and it is estimated that turbines worked by the passage of water into and out of these basins will give 5,000 h.p. at neap tides and ten times more at springs.

The flash point of oil is the lowest temperature at which the vapor will ignite or flash up momentarily without setting fire to the oil. If the temperature of the oil is increased beyond the flash point, the vapor is given off so rapidly that it will maintain a continuous flame, and the fire point is the lowest temperature at which the oil will burn continuously. The temperatures for the flash point and the fire point may be practically the same for some oils and 20 degrees apart in other oils. The temperature at which oil will spontaneously flash into flame without contact of flame or spark is still higher than the temperatures above spoken of.

ALCOHOL AND "WOODINE"

Circumstanmes over which nobody seems to have any control have people thinking and talking more or less about alcohol as a beverage constituent and to the determining of what is and what is not safely potable. The following from *Chemical and Metallurgical Engineering* should therefore be of interest to a number of readers and may be regarded as authoritative:

To the chemist "alcohol" is a generic term and, since he is familiar with a large number of compounds belonging to this same class, the term is not necessarily associated in his mind with ethyl alcohol for beverage use. Unfortunately, the public seems to be able to distinguish only two kinds of alcohol: denatured alcohol containing some evil smelling or ill tasting compound which obviously renders it unfit for human consumption, and alcohol which can be used in beverages. Wood alcohol, not being specifically designated as denatured (although, of course, it is used as a denaturing agent in many cases), is undoubtedly considered by many as belonging to the second class. The fact that containers of wood alcohol bear a label "poison" even has been explained by certain unscrupulous dealers as a ruse to prevent the Government from placing an internal revenue tax upon the contents. In order to prevent this confusion, manufacturing chemists have suggested to the Commissioner of Internal Revenue that the word alcohol be eliminated and that wood alcohol be known in future as "woodine." While this name may not meet with approval, viewed in the light of standard organic terminology, this action is a step toward the elimination of distinctions confusing to the non-technical mind.

Dr. Reid Hunt, in a recent bulletin on wood alcohol, prepared at the request of the American Chemical Society, calls attention to the fact that the senses of taste and smell cannot be relied upon to indicate the presence of wood alcohol and that poisonousness is an inherent quality of the substance, since it is oxidized in the human system to formic acid (and perhaps formaldehyde), while ethyl alcohol is converted into water and carbon dioxide, both harmless and easily eliminated. In view of the serious consequences which may result from ignorance in this connection, every chemist should devote his energy to the enlightment of the public regarding the dangers of wood alcohol.

DELIVERING CONCRETE BY COMPRESSED AIR

By C. W. GEIGER

IN THE construction of the Stockton Street tunnel in San Francisco, of a length of nearly 1,000 feet, the average day's run of concrete amounted to a charge of sixteen cubic feet every two minutes, mixed and forced in place 1,000 feet away by compressed air; at a distance of 300 feet, a charge was placed every minute. A rate of 40 batches per hour or about 190 cubic yards per eight hour day was a fair average for a steady run.

The concrete forms were laid to form pockets, and the concrete was driven into place wherever the discharge end of the eight inch pipe was directed. When a section of the tunnel was completed the pipe was merely lengthened for the next section.

The concrete mixing plant was located near the south portal. Sand and stone were supplied by gravity from material bins above. The pneumatic drum was situated under the ground near the concrete mixer. The concrete after being mixed was dropped into this drum through a horizontal pipe. After a charge of concrete, consisting of 16 cubic feet, was run into the pneumatic drum, the compressed air was used to shoot the mixture through the 8-inch pipe to any part of the construction work.

Showing the discharge end of the 8-inch pipe through which the concrete was driven by compressed air.

PRODUCTION OF LIQUID AIR FOR BLASTING

Application of unusual interest, and presenting matter of permanent intrinsic value, is *Technical Paper No.* 243 recently issued by the Bureau of Mines. The following is taken from its pages:

LIQUID OXYGEN

Liquid air used for blasting purposes is not the product commonly known under this name, but is more correctly designated as "liquid oxygen," for it contains 85 per cent. oxygen. Still higher concentrations of the oxygen can be obtained by evaporating the liquid air at ordinary mine temperatures, as the nitrogen, owing to its lower boiling temperature, evaporates more rapidly than the oxygen. As the oxygen evaporates also, although in proportionately smaller amount, it is clear that such a procedure is wasteful of oxygen. The loss, however, is negligible when the so-called "rectification" process is used. This process permits producing liquid air with 95 and even 99 per cent oxygen, but for blasting purposes a concentration of 85 per cent is sufficient. At this oxygen content the liquid "air" has a specific gravity of 1.1 and a temperature of 185°C. In spite of this low temperature the liquid does not burn the human skin on lightly touching it, and there is small danger of one's hand being injured if the cold liquid is accidentally spilled on it. However, the possibility of painful burns through contact with the liquid air should not be underestimated, Dietrichs cautions, in the handling and charging of cartridges.

PRODUCTION OF LIQUID AIR

The air liquefaction installations, Figs. 1 and 2, are electrically driven, and include an air compressor, solution pump, and ammonia compressor. The air is sucked through a purifier where it is freed from dust and carbon dioxide by means of a solution of caustic potash or soda. The solution is kept circulating by means of the small pump. The separator serves for separating out the solution carried along. The air then passes into a three-stage compressor. The pressure stage is the same as in all cylinders. After each pressure stage the temperature of the compressed air is lowered by cooling coils to the initial temperature, so that the compressed air leaves the compressor with a temperature of 15 to 20° C. The air then passes through a high pressure pipe into the precooler, where it is cooled by cold nitrogen escaping from the liquefaction apparatus. On leaving the preliminary cooler the air is freed from oil in an oil separator after having been heated again by the outside temperature; it then passes into a drier, where it is freed from moisture and from the last remnant of carbon dioxide by means of caustic potash or soda. After the air has thus been preliminarily cooled and purified it passes through a three-way valve into the cooler, where it is artificially cooled to 20° C. From the cooler the air passes into the liquefaction apparatus, where it is liquefied and separated into oxygen and nitrogen.

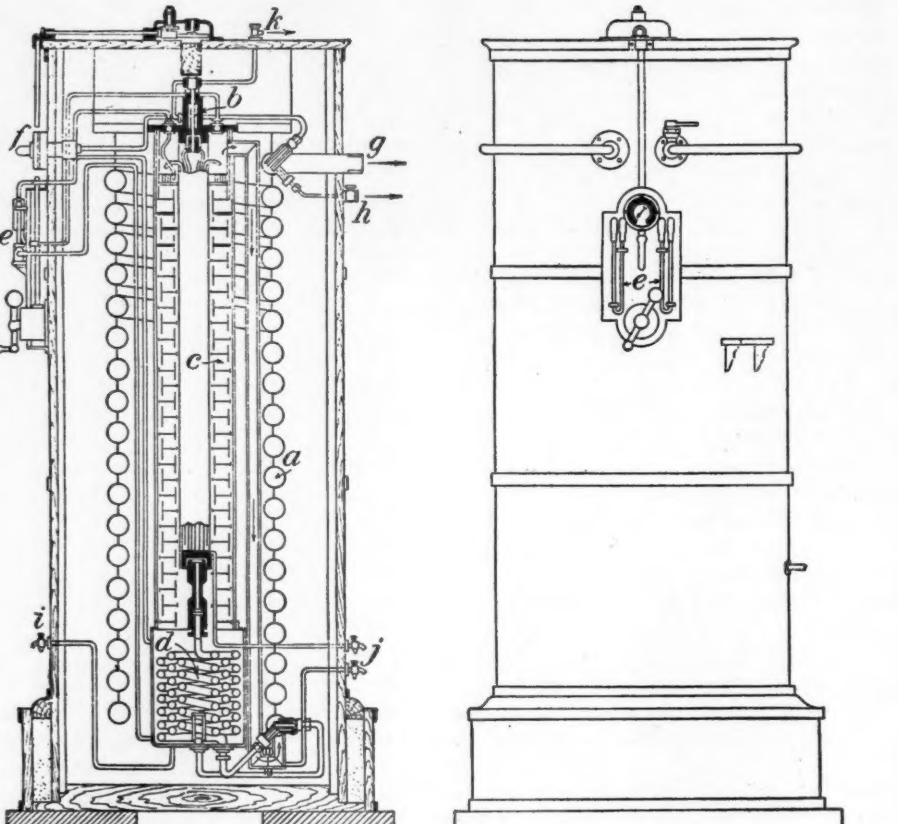


Fig. 2—Air liquefying apparatus.

STORAGE OF LIQUID AIR

The vessels in which liquid air is kept must be perfectly insulated against the outside temperature in order to confine the evaporation of the liquid to a minimum. This important requirement is met only by a vacuum; for this reason, double-walled, highly insulated vessels are used for the storage and

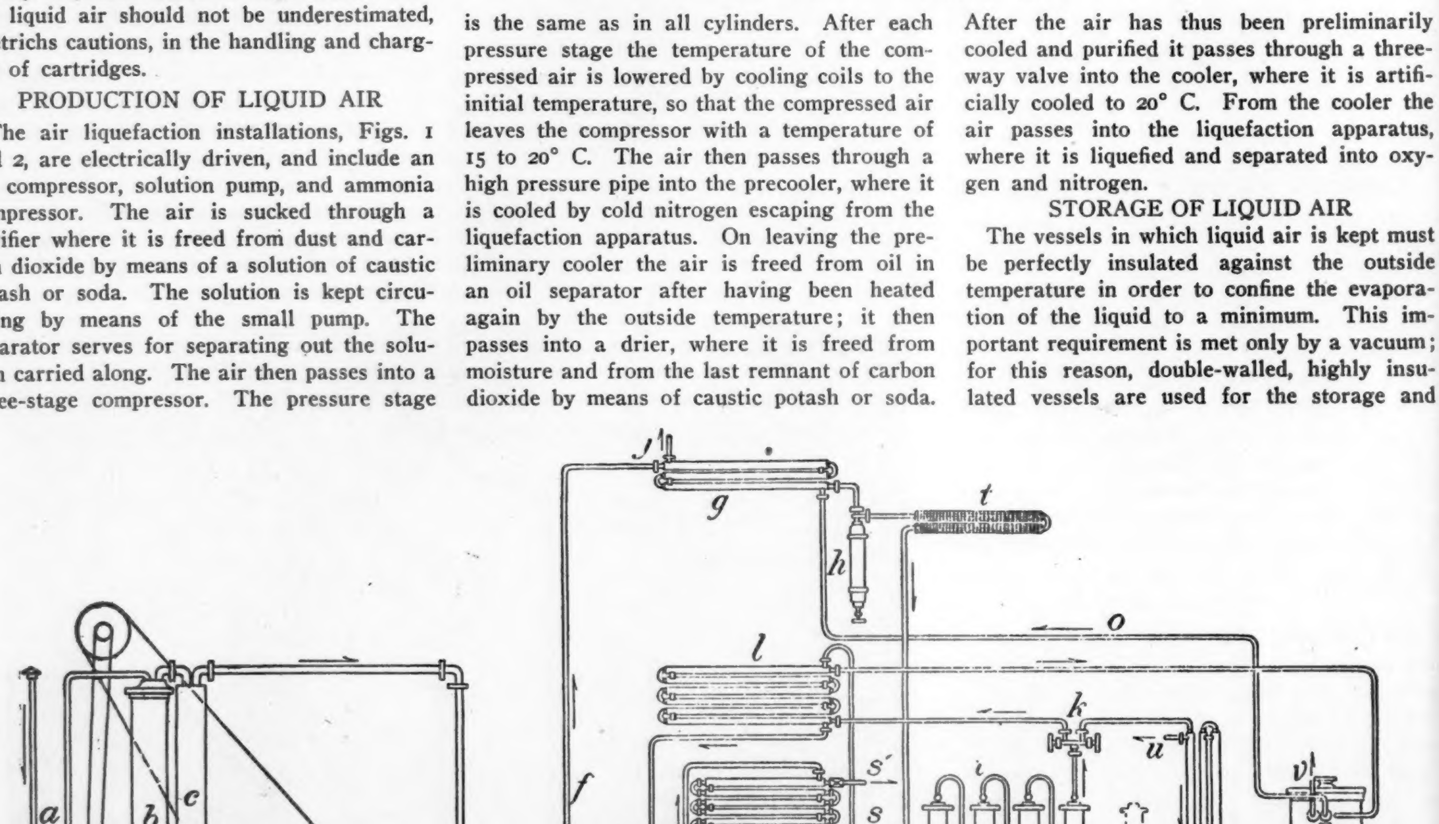


Fig. 1—Compressor arrangement for air liquefying plant.

transportation of liquid air. Copper and brass seem to be the most suitable material for this purpose. Glass would be the ideal material, but, owing to its fragility, it hardly comes into consideration in practice, and its use remains confined to laboratories. The bottles have one or several vacuum jackets. For the outer jackets steel may be used. For obvious reasons the shape of the container is almost exclusively oval or spherical.

Although the best and most efficacious metals are selected for the manufacture of the vessels, still there is no metal which in the long run does not allow air to pass through. On the other hand the requirements of the vacuum, in view of the economical storage of the liquid air, are too high to be met satisfactorily by the air pump alone. On this account the idea contained in the Dewar patent of 1905 is used for maintaining a more perfect vacuum.

Heated charcoal is placed in the space to be evacuated in the double wall of the container, evacuation is carried as far as possible with an air pump, and the connection is sealed. If the vessel is filled now with liquid air then the coldness is transmitted through the wall to the charcoal, which sucks up the remaining air and produces an almost perfect vacuum. By this procedure the required vacuum is generated anew at each filling of the container, and is kept up as long as liquid air is present therein. The mouth of the container must not be entirely closed as the intense gasification of the liquid leads to high and very dangerous pressures within a tightly closed vessel. The evaporation losses in these bottles amount to only four to six per cent in 24 hours.

CONDENSED INFORMATION CONCERNING AIR

Mascot Concentrates, "issued monthly by the American Zinc Company of Tennessee, Mascot, Tenn., for the benefit of the residents of Mascot and the employees of the company," is an unusually bright and attractive example of the class of publications which it represents. The following is among the things found in the September issue:

Air is a peculiar substance which we have on all sides—outsides—of us whether we want it or not—like creditors. It extends fourteen miles above us, but so far has been entirely sufficient, although air shipping may necessitate its being extended. Air is the cheapest thing we have. Enough to last a lifetime is thrown in with every town lot we buy. Air changes its temperature according to the seasons, although hot air may be generated during any season. There is also an air produced by instruments, vocal cords, cats, and so forth. This kind of air should be treated by itself. Wind is air with a determination to get somewhat else as quickly as possible. The wind idea originated in Chicago and is rapidly being taken up in other parts of the country. Instruments constructed for the purpose show that the air moves much more briskly in a campaign year than during any other. Fresh air is air that has just been made and not yet sampled.

POWER COST OF WIND RESISTANCE

THE INVESTIGATIONS which have been practically compulsory in connection with the modern development of aeronautics make it now possible to take up the study of air resistance to moving bodies, and the power consumed in overcoming it, with results that may be relied on. The problem is of as great importance to the railroad engineer as to the aviator.

The horsepower required to overcome the air resistance to a speeding locomotive increases with the cube of not merely the speed of the train but also of what is called the "created wind," which in the case of an ordinary express train may easily exceed 80 miles an hour.

It may now be taken as established that, for speeds within and even far beyond the range of railway speeds, the resistance of the air to a surface moving normally to itself is represented by the expression KAV^2, where A is the area exposed, V the speed, and K a constant. If A is measured in square feet, and V in miles per hour, K = .0033.

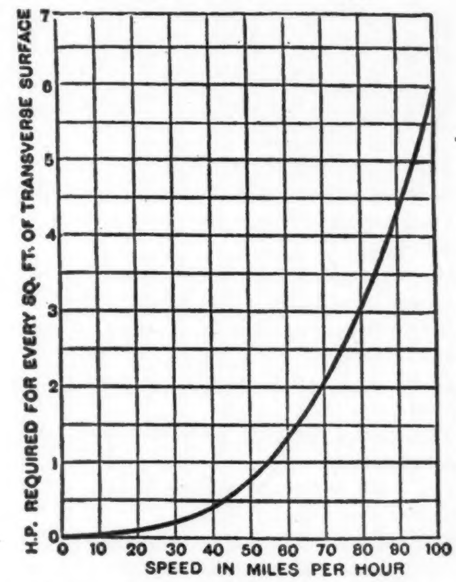


Diagram Power Cost of Wind Resistance.

The constant .0033 applies to the total resistance, and includes the now well recognized suction on the back of a moving body. For plane surfaces normal to the wind M. Eiffel found in his famous experiments that the suction accounted for one-third of the total. The frontal pressure alone may, therefore, be taken as $.0022\ AV^2$, and the horsepower required for every square foot of exposed surface is

$$\frac{.0022\ V^3}{375}, \text{ or roundly } \frac{6}{10^6} V^3$$

The value of this expression at 60 miles per hour is approximately one and one-fourth horsepower, and at 80 miles per hour three horsepower.

If we know the "all out" speed in a calm, say, 70 miles per hour, numerical limits can be assigned between which the speeds will lie for any ratio of train to wind speed. These limits are shown in the diagram.

It will be readily understood without entering into calculation that the speed of the created wind creeps up as the strength of the natural wind increases, and that 80 miles per hour is quite a moderate figure to take for it, while the diagram shows how sharply the demand for power runs up with any increase of speed in that neighborhood.

We now know fairly well what should be the best shape for a body which is to be driven through the air at speeds of the order under consideration. The front should be quite "bluff," a sharply conical or wedge-shaped form not being at all the ideal to be aimed at. What is required is to eliminate every square inch of transverse flat surface that can possibly be dispensed with, smoothing off projections, and putting in gentle curves parallel to the natural flow of the air.

INDUSTRIAL AIR CONDITIONING

In the production of gelatine products, low temperatures and constant low moisture conditions must be maintained. In confectionery establishments cool, dry air becomes a requirement. In the baking industry a high humidity with proper temperature maintained constant, eliminates important variables in the raising of dough and enables the baker to standardize time. In the photographic industry the proper conditioning of air has been practiced for some time, for otherwise there would be many days too hot or too damp for the production of satisfactory material. Even the printing art requires the conditioning of air, where several colors are used in the production of illustrations, for the perfect registration necessary for success cannot be expected under greatly varying atmospheric conditions. The silk industry has practiced conditioning for a long time.

ONE MAN'S PRAYER

Homer McKee once made a prayer, in which he said:

TEACH me that sixty minutes make one hour, sixteen ounces one pound, and one hundred cents one dollar.

HELP me to live so that I can lie down at night with a clear conscience, without a gun under my pillow and unhaunted by the faces of those to whom I have brought pain.

GRANT, I beseech Thee, that I may earn my meal ticket on the square and in the doing thereof that I may not stick the gaff where it does not belong.

DEAFEN me to the jingle of tainted money and the rustle of unholy skirts.

BLIND me to the faults of the other fellow, but reveal to me mine own.

GUIDE me so that each night when I look across the dinner table at my wife who has been a blessing to me, I will have nothing to conceal.

KEEP me young enough to laugh with my children and to lose myself in their play.

AND then, when comes the smell of flowers and the tread of soft steps, and the crushing of a hearse's wheels in the gravel out in front of my place, make the ceremony short and the epitaph simple.

"HERE LIES A MAN."

STORING COMPRESSED AIR IN CLOSED CROSS HEADINGS

The compressed air plant of the Alman pit, Gelsenkirchen, as described in *Gluckauf*, comprises three compressors with an aggregate output of 20,000 cu. m. per hour. (11,750 cu. ft. per min.) As this has been found insufficient for the needs of the pit, a reserve supply has been created by keeping the machines running during the change of shifts and at night, and storing the output. For this purpose two experimental cross headings, with an aggregate capacity of about 8,000 cu. m. (282,000 cu. ft.) have been closed by means of brick barriers of concavo convex form and nine feet thick, the firm sandstone being cut away on both sides to form the abutments.

The barriers are built in three sections, each two bricks thick, with intermediate spaces *a*, five to ten cu. m. (two to four inches) in width, the inner face of each section being smoothly plastered over before building the next; and the intermediate spaces being filled with rammed cement mortar. For the purpose of drawing off any water collecting in the chamber, a pipe *b*, fitted with stop valve, is laid on the floor. The compressed air is delivered into the chamber through a pipe *d*, which can be closed by means of a valve; and a pipe *c* connected to a pressure gauge, is laid near the roof to enable the pressure in the chamber to be measured.

The two chambers already constructed are situated on the main haulage level [492 m. (160 ft.) below the surface] and in horizontally stratified barren ground between the bituminous and gas coal groups of seams. As a consequence of the favorable results obtained, it is intended to construct a third chamber, with a capacity of about 6,000 cu. m. (210,000 cu. ft.)

Whereas, owing to the greatly increased consumption of compressed air, it was impossible to maintain the requisite pressure for more than a comparatively short time during the winding shifts when the compressors alone were in use, the installation of these storage chambers has enabled the pressure to be kept up all the time, the maximum pressure drop in periods of maximum consumption being not more than 1½ atmospheres. This highly favorable result is due to the fact that the chambers are located in rock that has not, so far, been affected to any practical extent by mining operations, and to the particular care bestowed on the construction of the barriers.

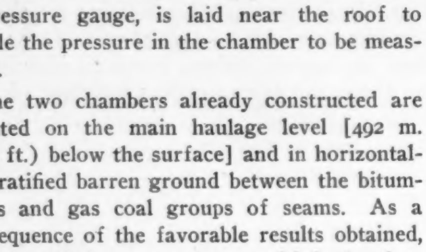


FIG. 1.—VERTICAL SECTION OF BARRIER.

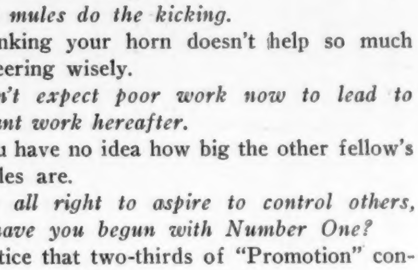


FIG. 2.—PLAN.

BRICKED BARRIERS TO CROSS HEADINGS.

LIFE AND BUSINESS

By B. C. FORBES
(Editor of *Forbes Magazine*.)

The fellow who isn't fired with enthusiasm is apt to be fired.

Excess is an arch enemy of success.

If top-notch effort yields you no happiness, there's something wrong either with you or your efforts. Sit down and do some analyzing.

After all, you've got to give full, fair value Or you won't last.

Carelessness and failure are twins.

The most valuable "system" is a good nervous system.

Saving is Having.

If you have an hour to spare, don't spend it with someone who hasn't.

Don't simply see how you can "put in the day." See how much you can put into the day.

Never contrive to make it easy for your concern to get along without you.

Make sure the prize you chase is worth the price.

If you cultivate your talents you'll always find an opportunity to use them.

When in a fix, sweating will get you farther than swearing.

Let mules do the kicking.

Honking your horn doesn't help so much as steering wisely.

Don't expect poor work now to lead to brilliant work hereafter.

You have no idea how big the other fellow's troubles are.

It's all right to aspire to control others, but have you begun with Number One?

Notice that two-thirds of "Promotion" consists of "Motion."

There is a better market for smiles than frowns.

The highest form of salesmanship is nothing but service.

The only influence worth having is the influence you yourself create.

The wages of idleness is demotion.

There is no higher rank than that of worker. No title can ever make a loafer a nobleman.

There must be output before there can be income.

Defeat is often a spur to victory.

The best reward is sense of worthy achievement.

Good times for all can only be the product of good work by all.

THIN SPOT IN EARTH'S CRUST

Within one mile of the surface of the earth in Stephens County, Texas, it is not improbable that heated lava exists. This may not be true of the entire county, but there certainly is evidence of near-surface heat in the region of Caddo. At a depth of about 3,200 feet, drillers there have found the heat. Sometimes the bit is slightly discolored by it and the instrument becomes so hot that when drawn to the surface it burns the naked hand.

According to W. F. Kerr in *Petroleum Age*, experiments have proved that heat in the earth at approximately that depth will discharge a shot of nitroglycerin. This is reported to have happened several times. The first explosion from this cause was unexpected.

"Stick" is a localism. Nitroglycerin, liquid as everyone knows, is sent down a well in long, slim cylindrical tins. The tins are each spoken of among the oil men and "shooters" as sticks.

Four "sticks" were placed in a hole, one of them being lodged in an oil sand at about 1,800 feet and the other three in the lime at about 3,200 feet. The top stick was discharged by ordinary ignition and the other left undisturbed, pending a test of results of the upper shot. Within sixty hours the lower sticks exploded.

At that time a theory was advanced that something from the upper explosion caused the lower explosion, but this was discounted later in further experiments when it was found that nitroglycerin left in a deep hole from forty to sixty hours was discharged solely by internal earth heat. And this has occurred a number of times since.

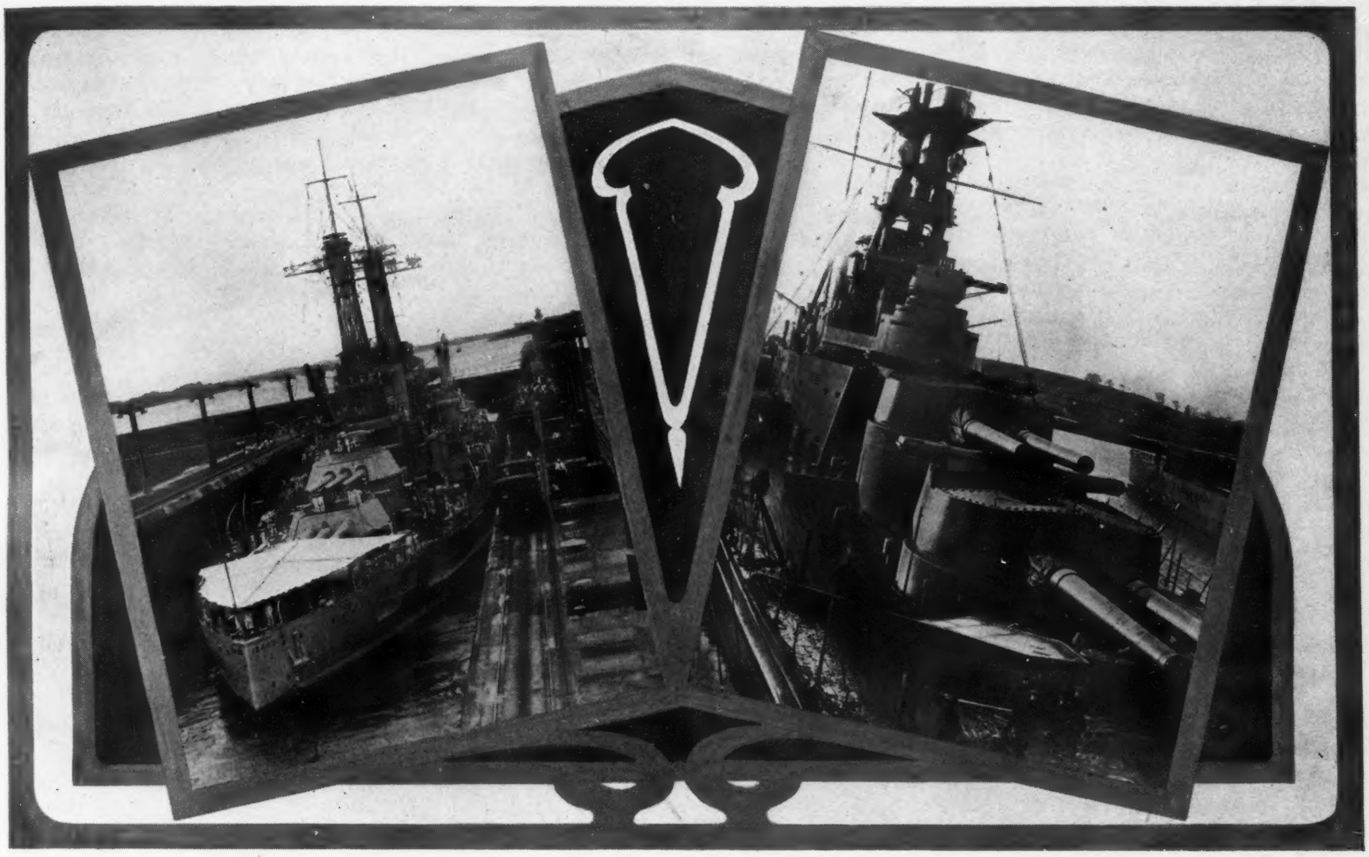
LOCATING NEW RAILROADS BY AIRPLANE

According to a recent "news letter" of the Air Service, United States Army, locating a railroad by aeroplane has been carried out by the Third Aero Squadron, Camp Stotsenburg, Philippine Islands, and one long flight has enabled a railroad engineer to determine which one of three general routes will be used for the new road. It is stated that many months and thousands of dollars have been saved in the work. Instead of three parties of locating engineers being sent out to make the survey, only one will now be necessary.

What is high speed for power machinery? Not so long ago it was a few hundred revolutions. However, with the introduction of high pressure steam and the steam turbine, there seems to be practically no limit except the rate at which steam will flow through an orifice. The speed at which some modern steam turbines operate would a few years ago have done justice to the vivid imagination of a Jules Verne.

The Shipping Board announces that it has entered into contract with the Atlantic Gulf Oil Corp. for delivery of 6,000,000 barrels of fuel oil at $1.25 a barrel and 9,000,000 barrels of crude petroleum at same price at Tecomate, Tex., during the year beginning January 1, 1921.

Two Great Battleships of Britain and America, Guardians of Civilization.



The modern battleship, unlike the man-of-war of earlier naval history, depends largely on the modern convenience of compressed air, which is used on board for a multiplicity of purposes. Air operates ammunition hoists, winches and repair tools, as well as steering gear on some classes of craft. It is used for torpedo tubes and is also employed in blowing out the gases from the big guns after they are discharged. Our pictures show two magnificent specimens of modern fighting craft; on the right is the H. M. S. "Hood," which is said to be the largest and most costly warship in the world. The photo shows the "Hood" just before she left the yards at Clydebank on her first trial trip. On the left may be seen the mighty "Idaho" of the Pacific fleet passing through the Panama Canal. It was recently announced, but unofficially, that the new battle cruisers, the "Saratoga" and the "United States," are to mount each a main battery of eight eighteen-inch guns. This type, if successful will be the heaviest gun ever used by any navy. The new cruisers will have 180,000 horse power each. It is said that it requires dynamos developing 456,972 horse power to illuminate New York at night; therefore three of such battle cruisers anchored in the Hudson could not only furnish New York's lighting, but have about 80,000 horse power to spare.

MOVIES OF THE BUREAU OF MINES

The Bureau of Mines has recently completed sets of films showing various phases of the mining and metallurgical industry for the purpose of loaning them where they can be used in the dissemination of useful special knowledge. It is hoped that the borrowers of these films will treat them with the same care that has been taken in preparing them. Those requesting the loan of any films belonging to the Bureau of Mines are expected to pay the cost of postage both from the Washington office and return.

DRIVING A TUNNEL MORE THAN A FOOT AN HOUR

Tunneling progress of 484 ft. in 432 hours working time was made last October in the 8 x 8 ft. drift of the Holmes mine, one of the Cleveland-Cliffs Iron Co.'s properties situated at Ishpeming, Mich. The rock was diorite, hard and dense. Drilling per round required from seventeen to nineteen holes aggregating more than 100 ft.

IMPROVEMENTS IN MANUFACTURE OF COAL GAS

One of the most important improvements in the manufacture of coal gas has been perfected by the engineers of a gas company in London, England. They have contrived to extract from the gas all the carbon bisulphide —a substance which, when burned, had a deleterious effect on health, and also on various materials. Throughout most of the nineteenth century, chemists and engineers strove to solve this problem, but success did not come till the year 1914. The war prevented the erection of plant to carry out the process, but the way is now open for the general adoption of a method which will make a gas flame as harmless to its surroundings as a candle. The process is a catalytic one, the extraction of the impurity being effected by a substance which remains unchanged in spite of its activity.

The Mexican Eagle Oil Co. has bought in a 20,000 barrel well at Los Naranjos field, Mexico. Well was drilled in at depth of 2,232 feet.

A SEVENTY MILE BOAT

Our speed records are continually rising far beyond any limits which could have been predicted at the beginning of this century. Dr. Alexander Graham Bell has produced a boat which can make its seventy miles an hour. When approaching its higher speeds it is no longer sustained by floating buoyancy, but skips along the surface of the water sustained by a system of planes which are distinct from the hull proper. These planes are like shutters of steel graduated in size with the smallest at the bottom, and as the speed increases these planes are the sustaining elements, lifting the trim hull bodily out of the water. Much higher speeds are expected to be realized by this device.

More than 1,700 employees of the General Electric Co., Schenectady, N. Y., have completed 25 years or more of service with that organization. Their combined term of service totals 47,709 years and their total age is 91,550 years. These men have formed a Quarter Century Club.

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President

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EDITORIALS

A SQUARE DEAL FOR ALIEN WORKERS IN AMERICA

THERE IS abundant proof on every hand that the Americanization of foreign-born workers in American industries richly pays. The Connecticut State Council of Defense, which has investigated the status of the non-English-speaking employee in the United States, has found that Americanization, in its full and broad meaning, "may be confidently expected to reduce industrial accidents, decrease labor turnover, increase production, improve health and morale of workers, and do much to allay social unrest."

If these things are true it follows that they have an important economic value to every employer of labor. A booklet issued this year by the Elliott Service Company sets forth, in convincing fashion, the economic urgency of education among non-English-speaking workers. The manuscript of this booklet was submitted to several authorities of high standing who have approved the tried and trusted remedies it suggests to meet some of the problems of shop and factory. Mr. ROBERT T. HILL, Director of Training, New York State Department of Immigrant Education, declared that the suggested programme of visualized information and stimulation of interest was directly in keeping with current movements in the field of industry and extension education.

Many of the thousands of executives that read these pages monthly are employers of alien-born labor. In mining, steel, lumbering, construction, transportation, and in all basic and fundamental industries, the unskilled and semi-skilled labor is done almost entirely by foreigners. In many industrial centres from fifteen to 25 per cent. of the entire population cannot speak English. In certain localities, in fact, more than one-half the workers are unable to read, write, or even understand our language. Moreover, we are informed, at least one-quarter of the immigrants who earn their bread in America are illiterate in their own languages, and of those in the country five years or more less than one-third have become naturalized.

On the face of them, these facts, if accepted, and there is no reason to doubt their accuracy as they are supported by Department of Labor statistics, indicate unmistakably that a prompt, effective, far-reaching and continued plan for Americanization is a natural, social, civic and industrial necessity of prime importance. There are public agencies seeking to bring about this result such as national and state bodies, our school and churches, but their progress is slow. They work with children of the coming generation, and with the adult when they can capture his attention in odd moments of tired leisure. But they do not get down to brass tacks in the industries themselves, and it is in that field, as far as economics and patriotism are concerned, that we are most concerned.

Our own pointed belief is, after much observation of "welfare work" among alien-born workers, that each large employer of foreign labor will get the most effective and direct results by tackling his own factory or shop problems as an individual undertaking. The workman spends most of his waking hours, his best and freshest hours, at his means of livelihood. There is the place to catch and hold his interest to such an extent that he voluntarily will supplement the employer's efforts later outside of working hours. Here, it seems to us, one is forced to agree with the experts of the Elliott Service Company, who declare that in industry there lies at once the great opportunity and the urgent obligation of the industrial manager. If far-reaching Americanization is to become an accomplished fact, every employer of foreign-language-speaking labor must make common cause with civic, social service and educational organizations. To return to our original contention—the employer controls by far the greatest part of his workers' time and energies, and therefore it follows that his opportunity to Americanize, develop and influence is proportionately greater than that of any other agency.

Looking at the subject in the light of purely cold-blooded business enterprise, and divorced entirely from every suggestion of general social service and civic duty, Americanization, it is well argued, is a highly profitable undertaking for the employer, and it justifies liberal expenditures in support of every means contributing toward the desired end.

It is suggested that the credit side of the Americanization ledger may be tabulated by the industrial manager as follows:

Reduced number of industrial accidents.
Lower labor turn over.
Increased ability to learn.
Better understanding of instructions.
Free communication between employer and foreman with workers.
Better quality of work.
Greater production.
Heightened interest in job.
Better industrial relations.
Fewer violations of plant rules.
Better discipline.
Better morale.
Less exploitation and abuse by crooks, sharpers and labor contractors.
Better understanding of hygiene and better health.
Less inclination toward radical and dangerous leaders—less unrest and lawlessness.
Earlier and better citizenship.

There is probably not a single one of the foregoing statements that is not a *proven* result of education, and not one which does not spell profit to the employer. A United States Senatorial investigating committee reported that non-English-speaking soldiers in the American draft army, who learned English in the camp schools, found after discharge that their new knowledge had increased their earning capacity $250 per year.

What is an American? It has been rightly said that the essential purpose of America is the "Square Deal." The Square Deal very clearly is the product of right living and straight thinking. As we have had grievous cause during recent years to learn to our national cost, the academic qualifications for citizenship do not make a real American—no, nor even to be born in the United States! The important part is spirit, viewpoint and mental attitude, together with conformity to a proper standard of living and conduct.

Americanization is a process of education and development, and it must be carried out in work and in play, in class room and assembly hall, in the home, and most of all, *in work*. There really can be no forced, no fraternalistic Americanization. It must be "sold" on its merits, and taken as a natural course by the individual seeking bigger opportunity for self-development.

A high-minded paternalism in industry is a splendid thing, and in relation to this subject it may best be expressed by the large corporate employer through his placing at the disposal of his workers from overseas, who have fled from harsh conditions in their native lands to our heartening haven beyond the Statue of Liberty, filled with hope and a childlike faith in our Square Deal, the means for them to enter into the spirit of America.

Their eventual gratitude will find certain expression in higher standards of thought and conduct and the stimulation of worthy ambitions—and it will automatically and simultaneously be reflected in conscientiously earned profits for the employer.

RESERVE BANK EARNINGS AND LIBERTY BONDS

AT ONE OF the new theatres there is a play now running in which reference is made to profiteering. One of the actors, in answer to the question, "What is profiteering?" creates amusement in the audience by replying, "Ask the Federal Reserve Bank." A Wall Street publication featured recently a comparative statement of the earnings of the Federal Reserve Banks, showing the increases made since 1918.

While there is a great deal of public interest in the Federal Reserve system yet few people take the trouble to study the principles on which the system is based. The Federal Reserve Banks are bankers' banks. They deal with banks, not with individuals. They provide a reservoir of reserves, taking the place of the individual bank reserves, which was always the first line of defense and self-protection when conditions became tense or panicky. The Reserve Banks also provide elastic currency and credit, designed to expand or contract as business conditions require. They also stabilize credit; that is, they exercise an influence in keeping down the volume of credit expansion.

All national and state banks endeavor to make as much money as possible for their stockholders,—not so with the Federal Reserve Banks. Their stockholders,—the member banks, can receive only 6 per cent. on the investment, no matter how large the earnings of the Reserve System may be. The Government is really the largest stockholder, for everything above this 6 per cent. that is not used to provide a surplus fund must be turned over to the Government and the Government can only use this money for the *purchase of Government Bonds or for placing additional gold behind greenbacks.*

The large earnings now being made by the Federal Reserve Banks are due mainly to the fact that the discount rate has been raised from 4¾ per cent. last year to 7 per cent. The object of this raise is to prevent their member banks from getting too much cheap money. A bank, like an individual, will restrain its borrowings if it has to pay high for them.

As these large earnings are turned over to the Government they will undoubtedly be used to purchase Liberty Bonds, hence the public should have a keen interest in increasing the earnings of the Reserve Banks as much as possible.

THE AUTOMOBILE AND THE AEROPLANE

THE ACCOMPLISHMENT of actual flight by a heavier-than-air machine was only a beginning. It at once suggested unlimited possibilities as to what it might accomplish, of the vast and varied service it might render the world, so that no enthusiastic imagining could well seem extravagant regarding it, and the military service in the short period of the great war rendered by this novel agent still in its crudeness, confirmed and broadened the confident planning as to its future.

As an invention, the same as with other great and revolutionary devices, the actual demonstration that the thing would really work was only the beginning of its developing and perfecting, and the adopting of it to the exacting conditions of reliable and constant service. It must be conceded that the determining and standardizing of the mechanical details and constituents of the apparatus has gone along with unprecedented rapidity until it is now practically ready for the most exacting service that may be required of it. Both in speed of flight, in attainment of altitude and in perfection and reliability of control anticipation and prediction have been surpassed.

All of which seems to be true enough as far as the airplane itself is concerned, but it is far from the whole story, and much is still to be done before flying becomes an established habit and fully fits into the life of the age.

In sketching in our minds the future of the aeroplane a comparison is suggested with the career to date of the automobile, and chiefly by reason of the sharp contrasts presented. The auto may be said to have come upon us all at once fully equipped to take up the work which the horse has monopolized through the countless ages, superseding and excelling him both for all purposes of pleasure and for the heaviest work of transportation and doing far more of it. It even finds the stable of the horse a perfectly satisfactory housing, and the driver of the horse ready at once to operate it, while all the world of humanity, old and young, without change or preparation can jump on just as they are for a ride or for unlimited travel. Just as the wealth of the class of ease and leisure has been poured without stint upon the racing horse, doing much for the perfecting of the breed and the attainment of the limit as to speed, so now is money from similar sources lavished, not to say squandered, upon the auto, so that now the most urgent demand is for constant rapidity of production.

With the airplane everything is as different as can be. Surely nothing was ever so completely handicapped and in so many ways, and it remains a supreme wonder that in spite of it all confidence in the great future that awaits it remains unshaken. Large housing capacity is a necessity for it at all times when not in flight so that it may be safe from the ordinary as well as the extraordinary vicissitudes of the weather. Ample field-space must be provided from which ascent may be made in safety, but more especially is the space demanded for landing, the scarcity of such suitable spaces in the proximity of the larger cities being one of the most serious hindrances to the establishment of airplane service. This demand alone is one of so great aggregate magnitude that it will not soon be provided for.

The airplane operator must be a technically informed and highly trained specialist, and however completely he may be filled with the theoretical knowledge required, and have it all quickly available, much experience also will be needed before he can first of all fully trust himself and then be trusted as he should be. The manipulation and control of the machine when in flight, it goes without saying, must be such that there shall never be an instant's let up in the continuity of propulsion or in the command of the direction and speed of flight, but there must also be the ability to know approximately the whereabouts and the whither when nothing is visible. While the machine itself has approximated what with our present outlook might be called perfection, the operator is still in need of instruments of delicate precision for his reliable guidance in flight and in determining especially his location and other conditions for the making of safe landings in predetermined locations. The number and variety of instruments already devised is large, a full equipment of them competing in cost with that of the machine itself, but still all the suggested requirements are not satisfied.

For the physical endurance of the operator, after his nerves have been adjusted to the unaccustomed experiences, the problem suggested is comparable with that of the sandhog, and chiefly by the great contrasts involved. He has to encounter rarity instead of density of atmosphere, and the changes of pressure occur with far greater rapidity. Whatever may be devised in this direction to meet the requirements of the operator of the machine, the professional and accustomed flyer will be still more necessary for the passenger who only flies occasionally or intermittently. Fliers, whether operative and responsible or not, will never be casual pickups, but must have their initial experience and preparation before becoming accustomed and dependable. It will be well, however, for both operator and passenger, to make the conditions as endurable, not to say comfortable, as possible, and the one condition most imperative is the maintenance of normal atmospheric pressure for respiration. The way is opened for this in the providing, as is now done, of a compressor or blower to supply air for the motor and maintain its full working power when the higher altitudes are reached. The same compressor would require but little enlargement to supply air also to a closed passenger cabin. The arrangement would be after all only another of the many instances in which the compressor is called in to help out in an emergency, and, as usual, it would do the job. R.

CONSERVATION OF FUEL OIL A PRESSING PROBLEM

THE AMERICAN Petroleum Institute has sent out an appeal covering the gasoline situation and urging that something be done to check the consumption of this wonderful and most useful fuel.

A careful study of the statistics shows that the amount of crude oil available during the period of low priced gasoline was so great as to excuse for the time being any great expenditure of effort on the part of the auto-motive engineer to conserve fuel. That period is now definitely past. Already, the limits of our vast oil reserves have been estimated and we know that they are not inexhaustible.

To say that waste of this natural commodity has occurred in production would be stating the case very mildly, but however that is all now past and fault finding will be of no avail if we are to take hold and inaugurate constructive measures to remedy or alleviate what promises to become a bad situation.

In the communication of the American Petroleum Institute, one very good suggestion is imparted which patriotically inclined automotive engineers will do well to seriously consider.

The Institute says the time has now come when, from the oil man's aspect it would seem as though the problem of the automotive engineer is to build engines that instead of going from seven to twelve miles on a gallon of gasoline will go twenty or 30 miles on the same amount and the problem is not to build engines to burn refined oil but some product of petroleum other than the present motor fuels, as at the present time there is not enough petroleum to go around and to meet all requirements.

This is a very practical suggestion and quite easy of accomplishment. Other countries than the United States have been leading the way in the development of the low gasoline consumption engine.

Any progressive auto engine builder must realize the economic drift and he will do well to heed the signs of the times.

The horse power of heavy cars could be cut down and the lighter and cheaper could be so equipped as to get all the speed desirable from a very much smaller amount of gasoline that is now used; also, the speed limit of automobiles could be fixed at about 25 miles per hour.

These proposals are all entirely feasible and can be made a reality through legislation. Moreover it would be popularly received by the people as public opinion is strongly in favor of conservation.

Legislation, the necessity of which is apparent, always finds a sympathetic response and is cheerfully accepted and readily obeyed.

There can be no questioning the urgency of fuel oil conservation at the present, as the industrial demands of the world during the next decade are very likely to far outstrip any previous period. The development of the oil engine with the increasing consumption of fuel oil will make the shortage still more acute. The cutting down of space aboard ship necessary for storage of fuel and the increased cruising radius have been strong incentives for the adaptation of this form of fuel for propelling ships. It is very simple to imagine the greater and greater demands of the industry as oil burning ships become more numerous.

It would therefore seem that the automotive engineer should sacrifice a little speed which is more or less generally useless as the crowded condition of our streets and roads make 25 miles an hour about the limit of safety.

WAR RECORD OF NAVAL CONSULTING BOARD

THE first to be organized among the civilian groups that aided effectively in the service of the United States Government, both prior to America's advent into the world war and afterward throughout the period of hostilities, was the Naval Consulting Board. In large measure is due to this body the readiness of the Navy to go into action immediately upon the declaration of war with Germany and for the maintenance of necessary supplies and new equipment required by the navy in the performance of its huge task of transporting millions of men and the protection of millions of tons of cargo across the seas.

A recent volume, the author of which is Capt. Lloyd N. Scott, late captain, U. S. A., and liaison officer to the Naval Consulting Board, has been recently published at the Government Printing Office, Washington, D. C., and contains the record of the Naval Consulting Board from its inception, in a letter written in 1915 by the Secretary of the Navy, Josephus Daniels to Mr. Thomas A. Edison, requesting that great inventor's patriotic assistance in the formation of a new department of the Navy to be composed of the keenest and most inventive minds that could be gathered together.

At that time, we are told, the navy had no present means of handling inventions received from the public except by sending them to the various bureaus of the navy, which were so overwhelmed with routine work that an idea having a germ of improvement could not receive the attention it deserved.

Thereafter some 24 men, leaders in the inventive, engineering and industrial world, who were closely in touch with the public opinion of the country, were gathered together, and monthly meetings were held in Washington and New York.

A plan of organization into sub-committees was worked out. It is impossible in the space here available to describe the personnel and work of the various committees in any commensurate degree. The author in his valuable work, who obviously was entirely familiar with the inside workings of the board, goes into a very complete description of the plans and workings of each committee, giving the most interesting intimate details.

In order that the needs of the nation should be adequately met, what later became known as the Committee on Industrial Preparedness, was formed with Howard E. Coffin as chairman, and the following members: W. L. Saunders, Lawrence Addicks, Wm. LeRoy Emmet, Thomas Robins, Benjamin G. Lamme, Benjamin B. Thayer.

Mr. Coffin's exceptional qualifications for just such work, developed by his experience in the standardization of the materials of the motor car industry, was the foundation of an industrial preparedness campaign which led to results of far-reaching importance and eventually developed into an organization by the national government for the prosecution of the war. Within a few weeks after its organization an inventory was taken of the industrial resources of the United States. The author tells us that the method evolved for taking this inventory, by using the services of the engineers of the country, without doubt resulted in determining the character of the government's structures for the prosecution of the war. The broad aim of the inventory was to secure information as to the facilities of the country for the production of materials needed in carrying on the war.

Simultaneously with the appointment of the committee there was started a publicity campaign to educate the public on preparedness. How luncheons were given for the leading publishers and editors of magazines and newspapers, co-operation arranged with the Associated Advertising Clubs of the World, and the American Press Association in preparing advertisements for a list of 15,000 to 20,000 newspapers and widespread billboard displays, and also industrial parades lasting from morning to night organized in numerous cities throughout the United States are recounted in one chapter. Incidents which took place and personalities that were present behind the scenes for formulating the plans for this campaign of propaganda of the Naval Consulting Board are fully discussed. This was one of the swiftest pieces of work ever done, it is stated, for a job of similar size and resulted in a tremendous patriotic response throughout the country.

The legislation creating the Council of National Defense was undoubtedly largely in consequence of this educational work. This council, although it was not generally recognized, was in fact the war cabinet of the administration. Its creation, this volume tells us, "bridged over a chaotic period and a period of inadequacy and lack of proper organization and personnel to handle a terrific job."

Notably among the achievements of the Naval Consulting Board was the invention and development of listening devices for detecting submarines, the introduction of protective measures for merchant ships and the investigation of inventions submitted by the public. The chapter dealing on this phase of the work is most instructive. About 110,000 ideas and suggestions were received and examined. The amount of work involved in this task was stupendous and the author states that owing to the necessarily hasty manner of organization the members of the board metaphorically took off their coats and did the work, which, in a properly organized board should have been done by salaried employees who could devote their entire time and attention to it. "It was very much," he says, "as if the individual members of a board of trustees of a university were to do the work of the president of the university and the secretary of the university as well as the work of the instructors and professors. By this analogy Mr. W. L. Saunders chairman of the Board could be likened to the president who acted as president of the university, and Mr. Thomas Robbins as secretary and treasurer. Both of these men were heads of large industrial enterprises.

A long chapter is devoted to "Inventive Accomplishments of Members" and it is replete with items of information concerning devices which became well known throughout the service.

This volume deserves a place in every public and private library as it is a worthy contribution to the literature of the World War. It is full of information regarding administrative war organizations, personalities and occurrences which had a direct and influential bearing on the operations of the government and gives most interesting side lights on happenings, the causes of which have been heretofore unknown.

The facts related in the foregoing will recall to mind the early days of America's intervention in the World War, a period of trouble and anxious thought and of disorganization in many places. To the calm, intelligent and well organized efforts of those civilian patriots who composed the Naval Consulting Board, is owing in a measure the successful outcome of the conflict.

Japan's imports for the first seven months of 1920 amounted to $885,000,000, while the exports amounted to only $636,000,000, the difference being nearly $250,000,000.

Contents for November

Book Reviews

STANDARD ELECTRICAL DICTIONARY, by PROFESSOR T. O'CONNOR SLOANE. An entirely new edition brought up to date—contains over 800 pages, nearly 400 illustrations and definitions of about 6,000 distinct words, terms and phrases. 1920 enlarged edition. Price $5. New York: The Norman W. Henley Co.

AS A REFERENCE book this work is entirely beyond comparison. The definitions are terse and concise and include every term used in electrical science.

In its arrangement and typography the book is very convenient. The word or term defined is printed in black faced type which readily catches the eye, while the body of the page is in smaller but distinct type. The definitions are worded so as to be understood by the non-technical reader. The general plan is to give an exact definition, and then amplify and explain in a more popular way. Synonyms are also given, and references to other words and phrases are made. This work is absolutely indispensable to all in any way interested in electrical science, from the higher electrical expert to the everyday electrical workman. In fact, it should be in the possession of all who desire to keep abreast with the progress of this branch of science.

SHOP PRACTICE FOR HOME MECHANICS, by RAYMOND FRANCIS YATES. Illustrated with over 300 engravings. Size 6x9 in.; 314 pp. Price $3.00. New York: The Norman W. Henley Publishing Co.

THOROUGHLY practical and helpful book prepared especially for those who have had little or no experience in shop work. The introduction is given over to an elementary explanation of the fundamentals of mechanical science. This is followed by several chapters on the use of small tools and mechanical measuring instruments. Elementary and more advanced lathe work is treated in detail and directions given for the construction of a number of useful show appliances. Drilling and reaming, heat treatment of tool steel, special lathe operations, pattern making, grinding, and grinding operations, home foundry work, etc., make up the rest of the volume. The book omits nothing that will be of use to those who use tools or to those who wish to learn the use of tools. The great number of clear engravings add much to the text matter and to the value of the volume as a visual instructor.

The Air Service has issued a statement explaining the object of Major Schroeder's recent flights at altitudes in which he made a world record. It says that there was long and careful planning and much experimental work was done before the flights were attempted. Future wars will be fought largely in the air, and, because of the development of anti-aircraft guns, much of the airplane work will be done at altitudes of 20,000 feet and over. For flight at these altitudes, the aviator must be provided with devices which will enable both him and his machine to function properly, and it is these facts which have caused the Air Service Division of the military service to carry on this highly scientific and very successful work.

THE BUREAU OF MINES of the Department of the Interior has published the following new publications:

BULLETIN 183. Abstracts of current decisions on mines and mining, reported from May to August, 1919, by J. W. Thompson. 1920. 167 pp.

TECHNICAL PAPERS

TECHNICAL PAPER 241, Blowholes, porosity, and unsoundness in alumnium-alloy castings, by R. J. Anderson. 1920. 34 pp., 5 pls., 1 fig.

TECHNICAL PAPER 245. Quarry accidents in the United States, during the calendar year 1918, by A. H. Fay. 1920. 52 pp.

TECHNICAL PAPER 250. Metal-mine accounting, by C. B. Holmes. 1920. 63 pp.

TECHNICAL PAPER 252. Metal-mine accidents in the United States, during the calendar year 1918, with supplemental labor and accident tables for the years 1911 to 1918, inclusive, compiled by A. H. Fay. 1920. 113 pp.

NOTE—Only a limited supply of these publications is available for free distribution and applicants are asked to cooperate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

A special type of dictionary has just been published by the Marconi International Code Company, Limited. It contains upwards of 38,000 leading English words and includes a glossary of about 3,000 technical words used in connection with wireless telegraphy and telephony. In the volume which has been compiled by Mr. Sidney H. Nayler, lecturer and demonstrator in wireless telegraphy at Marconi House, and King's College, London, every word is numbered and accurately defined. The work has been prepared for several especial purposes, among which are that it may serve as an auxiliary to the Marconi International Code, which is thereby made more flexible, comprehensive and precise, and that it may be used if desired, as a verbatim code, by which cable charges may be reduced.

The Arizona Supreme Court has sustained a decision of the Pinal County court awarding the Protestant Episcopal Church Corporation of Arizona judgment for $910.50 damages for the appropriation of a part of the church lot at Ray by the Arizona Hercules Copper Co. The company needed the ground for a railroad track to its ore bins, which are immediately behind the church. When the church complained of the noise, dirt, and general disorder thus caused answer was made to the effect that the principal industry of the region was mining, not religion, but the plea evidently did not save the case.

The effect on the growth of plants caused by increasing the amount of carbon dioxide in the atmosphere has been tried in Germany, and the results are said to have been very promising. The gas, obtained in the process of smelting iron ore, was supplied by pipes to an area of some seven acres, and the crops taken off this land were, from 82 per cent. upwards, greater than those from similar, but untreated, plots.

Notes of Industry

Recently completed tests by the Chemical Warfare Service show that all gases used in warfare except mustard and sulphur monchloride can be stored for long periods without deterioration. Even in the case of mustard gas, the deterioration is not great. All of the gases which were the subject of these tests had been in storage at least twenty months. Due to the corrosive properties of chlorine, some difficulty has been found in preventing its escape from containers after long periods of storing.

A cryogenic laboratory is to be established at once in Washington in connection with the helium work being done by the Bureau of Mines. The necessary funds for equipping the laboratory and conducting the work are being allotted to the Bureau of Mines from appropriations made to the Army and Navy Departments. The work in this new laboratory will be directed by R. B. Moore, the chief chemist of the Bureau of Mines.

The Griscom-Russell Company, 90 West Street, New York, have recently placed on the market a new oil heater unit of the straight tube type. This is to supplement a previous coil heater line.

The oil heater is designed for the preheating of fuel oil before it goes to the burner and thus insures complete atomization of the oil under boilers or in furnaces. The oil is pumped through the tubes and high pressure steam in the shell serves as the heating medium.

The Bureau of Foreign and Domestic Commerce, Latin-American Division, in its report states that Mexico is one of the largest Latin-American customers for automobiles, the 1920 exports of motor vehicles from the United States to Mexico having been exceeded only by those to Cuba, Argentina and Brazil.

By means of compressed air, which will be forced into the hull of the wrecked cruiser *Milwaukee,* it is expected within a short time to make a salvage test on the Pacific Coast which will be of unusual interest. When it is washed shoreward an opening will be made and the engines and boilers removed, and it is hoped that every fragment of the cruiser can be saved.

Compressed air was used recently at the city wells in Ogden, Utah, in tests made to accelerate the city's water supply. It will take a few days to complete the tests, and at that time city commissioners will be able to decide whether or not the city will be able to operate pumps at the wells, or develop water projects in the South Fork canyon.

According to the Geological Survey's report, the average daily production of electricity by public utility power plants during January was 124,600,000 kw.-hr., during February 119,800,000 kw.-hr., and during March 121,800,000 kw.-hr. Of this 33 per cent. in January and February and 38 per cent. in March was produced by water power. To help produce this energy 10,247,947 tons of coal, 3,481,742 barrels of oil and 4,553,228 cubic feet of gas were consumed.

THE AIR HE BREATHES

Announcement comes from Geneva that a silencer for airplane engines, more highly developed than an automobile muffler, has been invented by the chief engineer of a Swiss airplane firm.

Kansas wheat crop estimated at 147,000,000 bushels, is second largest in its history and the corn crop, estimated at 127,900,000 is the largest in five years.

The National Pneumatic Company recently gave their employees an outing, at which a band concert was given by the Halbforster Band of Elizabeth, N. J. Various kinds of races were enjoyed by both sexes and suitable prizes offered. In the evening dancing was indulged in until a late hour.

A new CO detector, devised by Professor C. R. Hoover, for use in mines, is claimed not only to reveal the presence of the gas, but to indicate its quantity. It comprises a small glass tube filled with an iodine salt, pumice stone, and fuming sulphuric acid; carbon monoxide admitted to the tube in air is revealed by a change in the color of the chemical mixture to green. The depth of the color gives a gauge for the percentage of dangerous gas in the atmosphere.

The electric furnace in actual use has reached the temperature of 3,500 deg. C. Recent experiments, have, however, developed a furnace which gives a temperature of 4,500 C., enough to volatilize diamonds. A comparison of these temperatures with that of the sun which is estimated at 5,000 C., 9,032 F., gives a striking idea of what can be accomplished in handling refractory substances with electric heat.

Chile Copper Co. produced 8,172,000 pounds of copper in April compared with 9,256,000 in March.

Metal alloys intended to resist corrosion by acids and alkaline solutions have been prepared recently in the metallurgical laboratory of the Mid-west Engine Co., Indianapolis. The metal will resist all acids except nitric and also many alkalis according to the officials of the company.

The United States Department of Agriculture is producing gas by the destructive distillation of wheat, oat and rye straws. Although an automobile has been operated with the new combustible and it has been used for illuminating purposes and cooking, it is still in an experimental stage.

The Dutch shipping companies are at present obliged to pay income tax and excess profits tax in many countries visited by their boats, whether they have offices of their own there or not. This is the case in the United Kingdom and its Colonies, France, Spain, the United States, and Greece, whereas foreign boats calling at Dutch ports are not liable to such taxation. Various shipping interests in Holland have therefore urged the Ministry of Finance to impose the same taxes on foreign shipping as those payable by Dutch vessels abroad.

Latest U. S. Patents

AUGUST 17

1,349,608. AIR-WASHER. William H. L. Donaldson, St. Paul, Minn.
1,349,671. PUMP FOR INFLATING PNEUMATIC TIRES. Enoch P. Huitin, Flint, Mich.
1,349,876. APPARATUS FOR BURNING FUEL. Abner Doble, Detroit, Mich.
1,349,886. ELASTIC-FLUID TURBINE. Oscar Junggren, Schenectady, N. Y.
1,349,964. VACUUM CLEANER-MACHINE. Oliver A. Kalbfus, Baltimore, Md.
1,349,993. VACUUM-TANK. Lynn A. Williams, Evanston, Ill.
1,350,051. GAS-BURNER. Lloyd Wilson, Keswick, England.
1,350,068. PNEUMATIC-TIRE-FILLING DEVICE. Harold B. Cody, Palm Springs, Cal.
1,350,102. THROTTLE-VALVE FOR FLUID-PRESSURE TOOLS. Henry J. Kimman, Cleveland, Ohio.
1,350,138. CUT-OFF AND RELIEF VALVE FOR AIR-BRAKES. Edward P. Clauss, Lyons, N. Y.
1,350,151. VACCUM-FEED CARBURETER. Pierre P. Gilles, Springfield, Mass.
1,350,159. AIR-COMPRESSOR. Sven A. Johnson, Brooklyn, N. Y.

AUGUST 24.

1,350,342. VALVE FOR PERCUSSIVE TOOLS. William A. Smith, Easton, Pa.
1,350,396. VACUUM-PUMP. Burt R. Van Valkenburg, Oakland, Calif.
1,350,414. HYDRAULIC AIR-CUSHION. Jesse D. Langdon, Waterville, Wash.
1,350,438. FLUID-PRESSURE VALVE. Joseph Davidson, East Point, Ga.
1,350,439. LINT-COLLECTION SYSTEM. Joseph Davidson, Greenville, S. C.
1,350,467. PNEUMATIC-TIRE DRIVE FOR DYNAMOS OF RAILWAY-CARS. Edward Posson, Chicago, Ill.
1,350,505. PERCUSSION-TOOL. William H. Keller, Grand Haven, Mich.
1,350,517. COMPRESSED-AIR DEVICE FOR HANDLING GASOLENE. Wiley H. Pridgen, Creek, N. C.
1,350,666. STORAGE CYLINDER OR VESSEL FOR COMPRESSED AIR OR GAS. Stephen James Murphy, Drogheda, Ireland.
1,350,724. MULTISTAGE CENTRIFUGAL BLOWER. Thomas W. Green, Trenton, N. J.
1,350,745. ROTARY AIR-PUMP. Ira H. Spencer, West Hartford, Conn.
1,350,850. AUTOMATIC PNEUMATIC CARD-TABULATING MACHINE. Arthur S. Trew, Portland, Oreg.
1,350,926. AIR-PUMP INFLATING PNEUMATIC TIRES. Joseph Marie Etienne Franc, Andancette, France.
1,350,927. CENTRIFUGAL COMPRESSOR. Joel Gomborow, Lynn, Mass.
1,350,941. CENTRIFUGAL COMPRESSOR. Richard H. Rice, Lynn, Mass.
14,937. (Reissue). AIR-LIFT SEPARATOR-PUMP. Oran M. Pruitt, Indianapolis, Ind.

AUGUST 31.

1,351,032. VACUUM-CLEANER. Alva J. Fisher, Evanston, Ill.
1,351,176. AIR-PUMP. Charles G. Lillos, Minneapolis, Minn.
1,351,192. VACUUM MILK-RELEASER CHAMBER. Charles E. Somers, Milwaukee, Wis.
1,351,210. PUMPING MECHANISM FOR STATIONARY VACUUM-CLEANERS. Paul Heiliger, Chicago, Ill.
1,351,269. COMPRESSOR AND MOTOR-STARTER. Morris C. White, Los Angeles, Calif.
1,351,337. MILKING-MACHINE. Herbert A. McArthur, Montreal, Quebec, Canada.
1,351,397. AIR FORCE-PUMP. John M. Missouri, Montrose, Minn.
1,351,425. PNEUMATIC SHOVEL. Alonzo W. Kaney, Chicago, Ill.
1,351,480. PNEUMATIC OR COMPRESSED-AIR-CUSHION BED. Richard A. Leigh, Denver, Colo.
1,351,510. VACUUM GASOLINE-PUMP. George E. Friesen, North Yakima, Wash.
1,351,581. SAND-BLAST MACHINE. Charles F. Motz, Monaca, Pa.
1,351,610. VACUUM OIL-CUP. Harry F. Bloom, Toledo, Ohio.

SEPTEMBER 7.

1,351,780. AIR-VALVE. William Charles Mead, Toronto, Ontario, Canada.
1,351,847. AIR-PUMP. Jacob G. Gerhart, Fredericksburg, Pa.
1,351,871. MOLDING-MACHINE. Edward A. Pridmore, La Grange, Ill.
1,351,979. PROCESS AND APPARATUS FOR DREDGING BY SUCTION. Marcel Valentin, Mexico, Mexico.
1,352,013. COMPRESSED-AIR PUMP. Henry Mandelbaum, Brooklyn, N. Y.
1,352,072. APPARATUS FOR THE CONCENTRATION OF ORES. Fleury James Lyster, Broken Hill, New South Wales, Australia.
1,352,107. PUMP OR COMPRESSOR. James H. Wagenhorst, Akron, Ohio.
1,352,191. PNEUMATIC TOOL. Frank L. Hemig, Chicago, Ill.
1,352,348. AIR-PUMP. Shirley H. Bossart, Birmingham, Ala.
1,352,384. VACUUM SNOW-SWEEP. Arthur B. Rishel, Goddard, Kans.

SEPTEMBER 14.

1,352,428. ROCK-DRILL. Harry M. Chase, Denver, Colo.
1,352,509. AIR-CONTROL DEVICE FOR ENGINES. Leslie W. Griswold, Des Moines, Iowa.
1,352,520. VACUUM-CLEANER. Floyd L. Leland, Flint, Mich.
1,352,626. SANDING DEVICE. Henry Power, Montreal, Quebec, Canada.
1,352,726. MILKING MACHINERY. Norman John Daysh, Poughkeepsie, N. Y.
1,352,743. FLUID-PRESSURE MOTOR. Thomas Hall, Harrisburg, Pa.
1,352,750. ROTARY AIR - COMPRESSOR. Henry O. Jackson, Denver, Colo.
1,352,942. PNEUMATIC FOOT. Lewis Dodge and Charlie B. Dodge, Moore Bluff, Nebr.
1,352,952. WIND-MOTOR. James G. Gracey, St. Louis, Mo.
1,353,098. REGULATOR FOR AIR-COMPRESSORS. Charles Wainwright, Erie, Pa.
1,353,100. AIR - COMPRESSION POWER PLANT. Nathaniel B. Wales, Detroit, Mich.
1,353,112. LIQUID-FUEL BURNER. William Clarke, Montreal, Quebec, Canada.

SEPTEMBER 21

1,353,290. COMPRESSED-AIR-VALVE DIAPHRAGM. Iver Stokke, Sioux Falls, S. D.
1,353,415. PNEUMATIC VALVE. Joseph N. Newsom, Harry E. Harder, and William F. Leschen, St. Louis, Mo.
1,353,570. MILKING APPARATUS. Laurits Dinesen, Minneapolis, Minn.
1,353,639. VACUUM MILKING-MACHINE. Claude Hudson Davis, Wanganui, New Zealand.
1,353,656. FLUID-OPERATED MOTOR. Charles L. Heisler, Schenectady, N. Y.
1,353,753. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Charles V. Jameson, Chicago, Ill.
1,353,796. FLUID-OPERATED PERCUSSIVE TOOL. Harold I. Stage, Easton, Pa.

British Patents.

143,808. VENTILATING SYSTEMS. J. P. Griffiths, of Durban.
143,979. PNEUMATIC PERCUSSIVE TOOL. H. E. Lloyd, Tipton.
144,131. PAINT SPRAYING DEVICE. G. L. Ward, London.
143,470. COMPRESSOR. G. J. Butler, J. A. Vielle & E. W. Jodrey, London.
143,732. PNEUMATIC DRILL. C. H. Stevens, London.
143,769. VALVE CONTROL MECHANISM. Cole, Marchant & Morley, Ltd., of Bradford, R. S. Brailsford, W. W. Spooner & A. Brailsford, of Bradford.
144,392. RIG FOR PNEUMATIC TOOLS. H. Wilson, Sunderland.
144,393. STOP MOCK. W. H. Dorman & Co., Ltd., and J. Hanson, of Stafford.
144,432. BRAKE APPARATUS. J. W. Cross and The British Air Brake Co., Ltd., of Lon-
144,514. RIG FOR PNEUMATIC TOOLS. J. Wilson, of Dumbartonshire.
don.
144,796. BRAKE. McKenzie, Holland and Westinghouse Power Signal Co., Ltd., of London, and F. M. Castleman of Rotherham.
143,976. COMPRESSED AIR TURBINE. A. L. Lawrence of London.
144,536. HOSE PIPE COUPLING. M. Docherty of Glasgow.
144,797. RAILWAY PROPELLING RAMS. McKenzie, Holland and Westinghouse Power Signal Company, Limited, of London, and F. M. Castleman of Rotherham.
144,143. COMPRESSOR. W. G. Hay, Manchester.
144,871. SAND BLAST APPARATUS. C. H. Hollings of London.
145,126. VALVE. J. C. Hansen-Ellehammer, of Copenhagen.
145,179. ATOMISER. Professor H. Maxwell-Lefroy, and P. E. Cheesman, of London.
145,199. BRAKE APPARATUS. J. W. Cross and The British Air Brake Company, Limited of London.
144,165. ROTARY PUMP. C. H. Adams, of York.
144,129. COMPRESSOR. B. Parent, of Paris.
144,201. COMPRESSOR. S. Larsson, of Stockholm.
144,225. COMBINED PRESSURE GAUGE AND REGULATOR. E. Hipkiss and S. W. Amphlet, of Birmingham.
144,594. PARAVANE; PNEUMATICALLY OPERATED CUTTER. C. D. Burney, of Alresford.
135,204. REMOVING DUST FROM COAL. Maschinenbau-Anstalt, Humboldt of Koln-Kalk, Germany.

A COMPACT TURBO BLOWER

A Rateau high-speed turbo blower, weighing slightly over 4,000 lbs., is in use by the Famatina Mining Company, Argentine. Tests made show that at a speed of 36,000 r.p.m. the machine delivers some 4,000 cu. ft. of air at 21 lbs. pressure. Two units of this type working in series can compress air at 100 lbs. pressure in small units, and three units in series would give a compression as high or higher than 100 lbs. for larger power machines. The critical speed of the machine is above 36,000, and the normal speed 22,000 r.p.m. The diameter of the blower is about 10 in., and the entire blower end is composed of one wheel only. The turbine rotor comprises three wheels keyed on the shaft. The first wheel receives boiler steam, and two low-pressure wheels in parallel receive the steam discharged by the first wheel.

A CHRONIC COMPLAINT

At a street meeting of United Americans the speaker was interrupted by a man with a foreign accent who cried out, "This is a government of plutocrats; why don't you give the down-trodden workman a chance?" To this the speaker replied: "The man who has just interrupted this meeting is wearing a $15 hat a $20 shirt, a $25 stickpin, a $75 suit of clothes, and I can't see his shoes. He bears every evidence of prosperity. Does he look like a down-trodden workman? Has he any right to abuse the Government under which every opportunity has come to him? If he has anything more to say we shall be glad to hear it."

The following item is intrinsically worth preserving. It is proper, however, to say that no political use should be made of it in the present campaign: An American firm got a nice order for threaded pipe from Australia. It made application to Washington for permit to ship, but the permit was refused. Because we were at war? Because we needed the pipe for home consumption? No. It was refused because "the application for permit did not state whether the pipe-thread was to be of linen, silk or cotton."

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